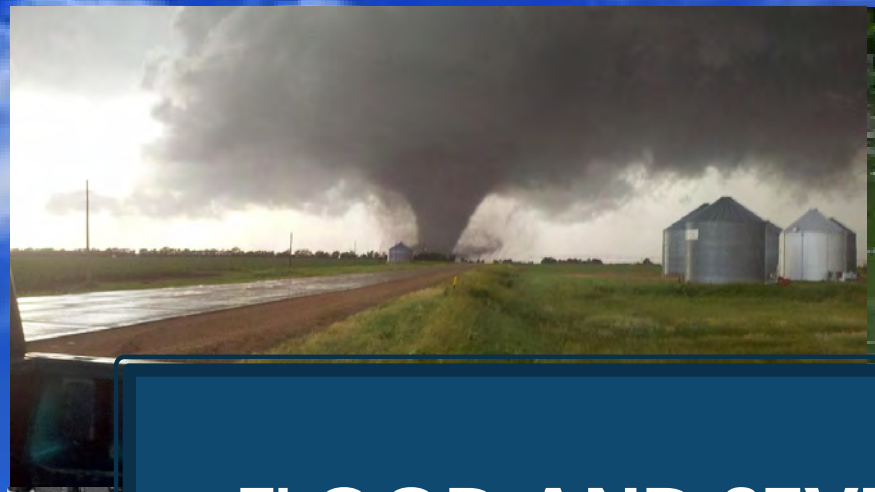
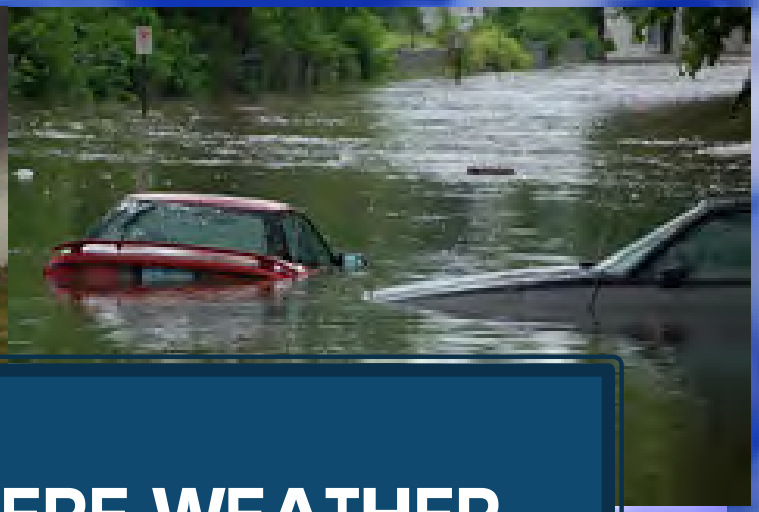
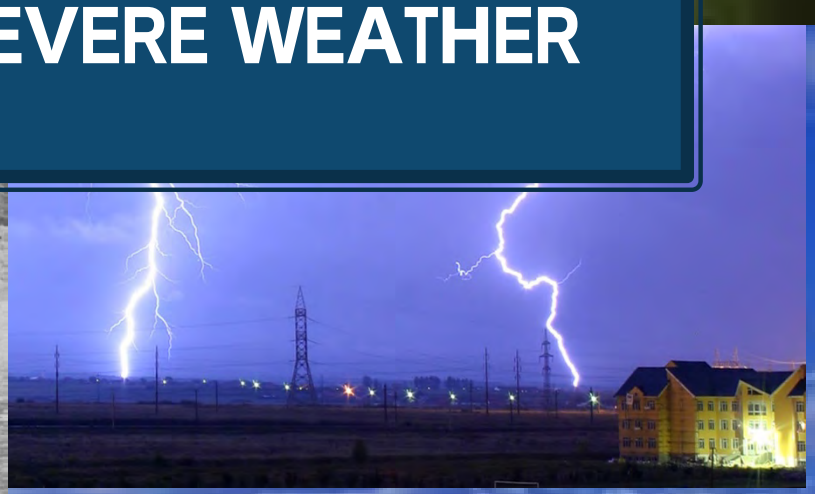
Data in the Classroom

psteffen@imsa.edu





FLOOD AND SEVERE WEATHER

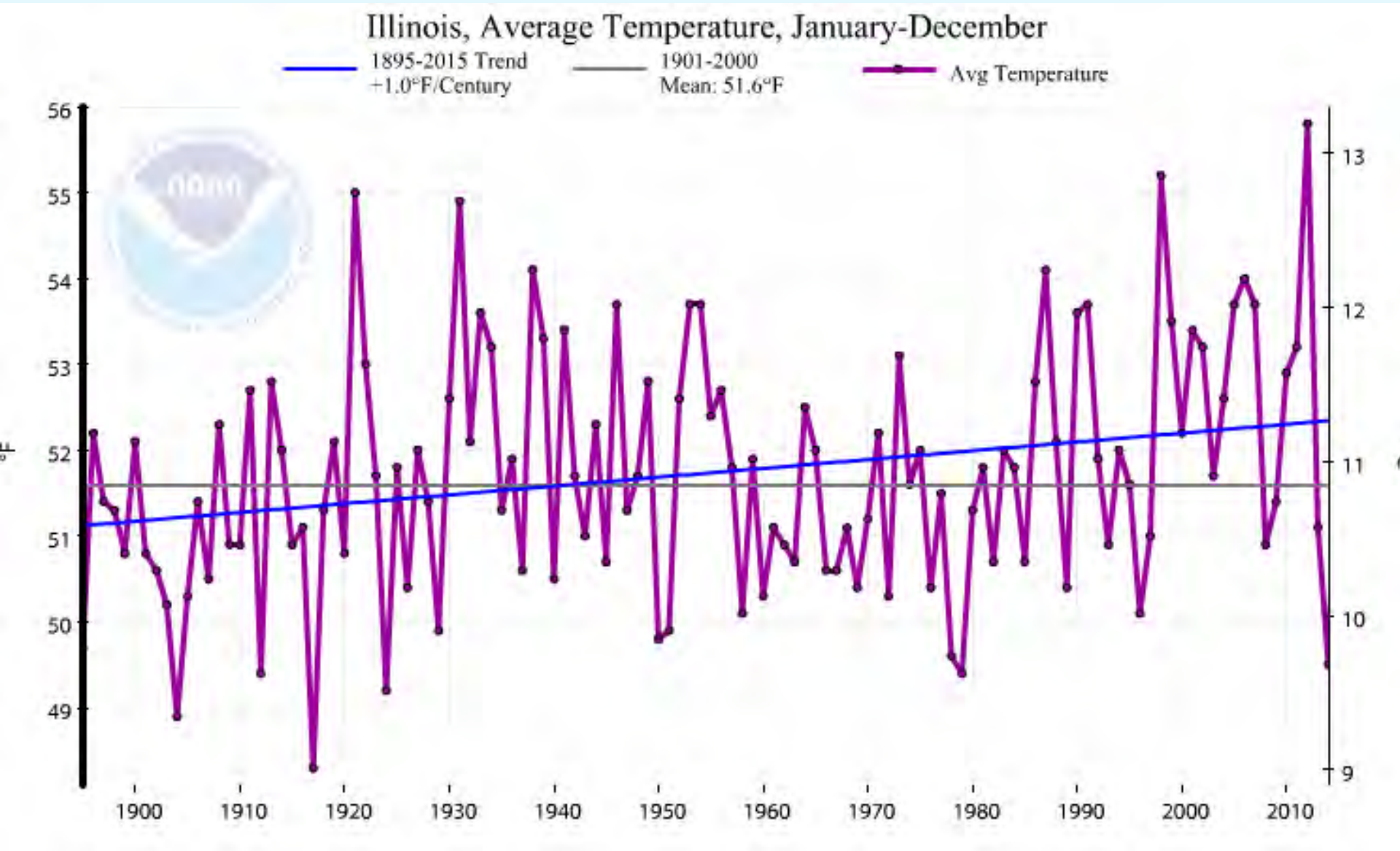


THE NEW NORMAL

- Spring is arriving sooner.
- Dangerously hot weather is occurring more often.
- Heavy downpours, and flooding affect health, agriculture, forestry, transportation and water quality.
- Increased extreme rainfall events.
- Increased humidity and degraded air quality.
- Great Lakes ice coverage has declined substantially.

http://elpc.org/wp-content/uploads/2019/03/Executive-Summary-GLClimateChange.pdf

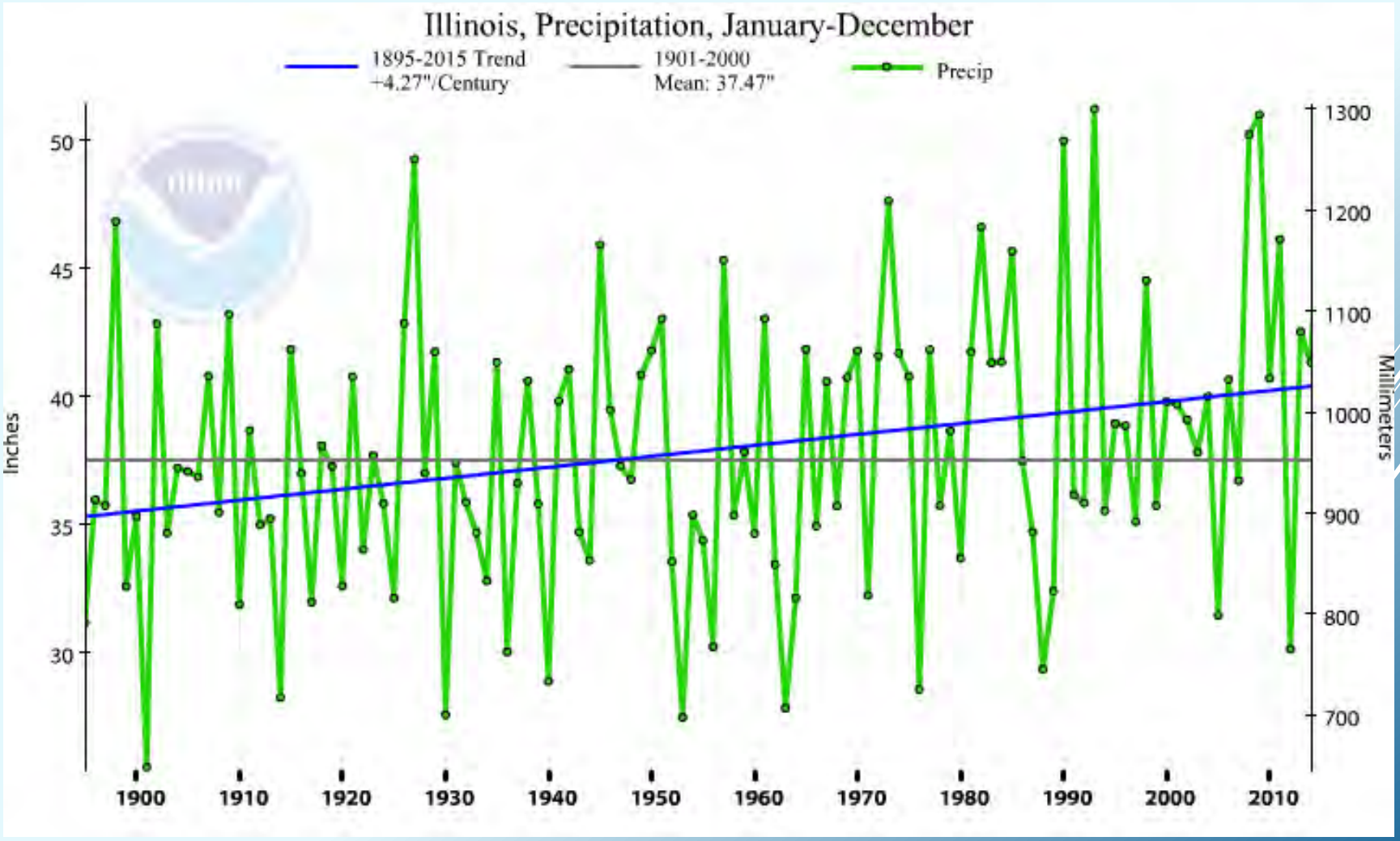
https://nca2014.globalchange.gov/highlights/regions/midwest

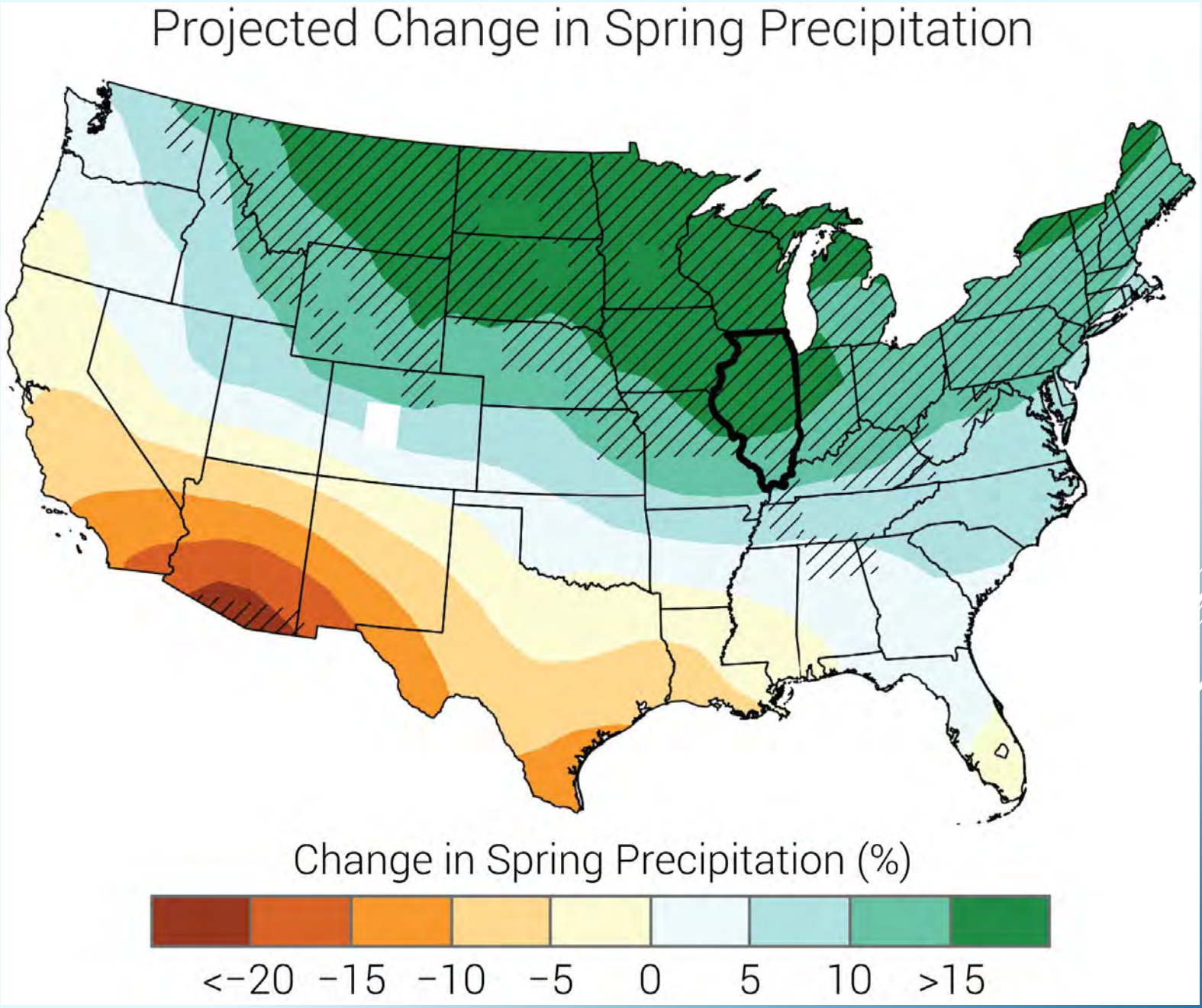

Illinois, Average Temperature, January-December
1895-2015 Trend
+1.0°F/Century
1901-2000
Mean: 51.6°F
Avg Temperature
°F
56
55
54
53
52
51
50
49
13
12
11
10
9
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

- A dramatic increase in extreme precipitation events in Illinois.
- Extreme rainfall events and flooding have increased during the last century.
- The increase in heavy downpours has contributed to the discharge of untreated sewage due to excess water in combined sewage-overflow systems in the Midwest.
- We expect stronger droughts, bigger heat waves, stronger storms and heavier rainfalls where the rain is occurring. Managing water will be a major challenge.

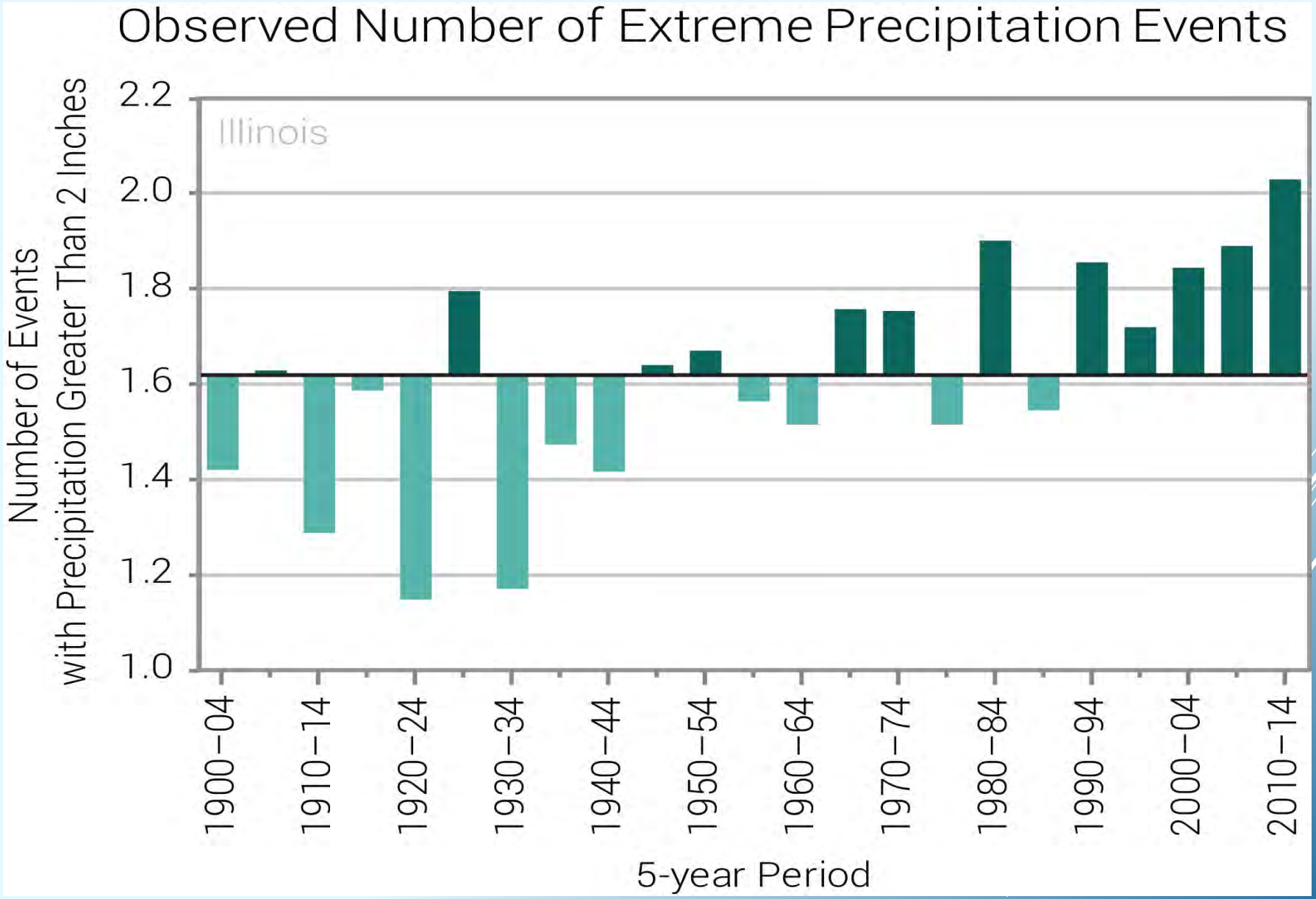
https://www.scientificamerican.com/article/kevin-trenberth-on-climate-change-and-tornadoes/

Precipitation in spring and summer has been above average over the past two decades, affecting agriculture in both positive (adequate soil moisture) and negative (delays in spring planting) ways.





https://statesummaries.ncics.org/chapter/il/

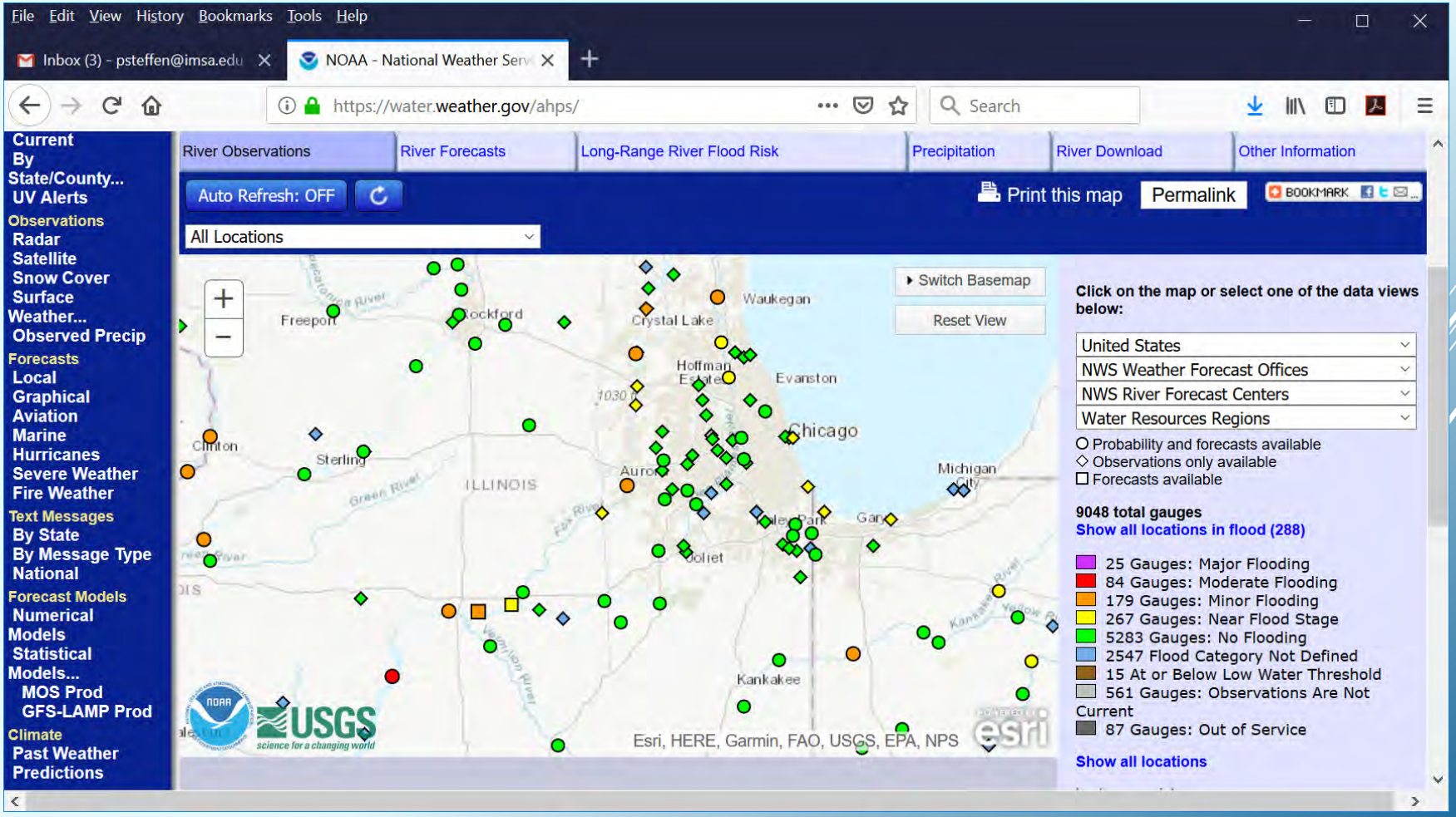


https://statesummaries.ncics.org/chapter/il/

April 2013 Record Des Plaines and Illinois River Flood

- Record rainfall produced flash flooding over Northeast Illinois.
- A new state 24-hour rainfall record set when Aurora received 16.94 inches of rain.
- Major flooding along portions of the Fox, Illinois, and DuPage Rivers occurred, causing widespread flood damage.
- $375 million from flash flooding and river flooding

Visit the National Weather Service at http://water.weather.gov/ahps/

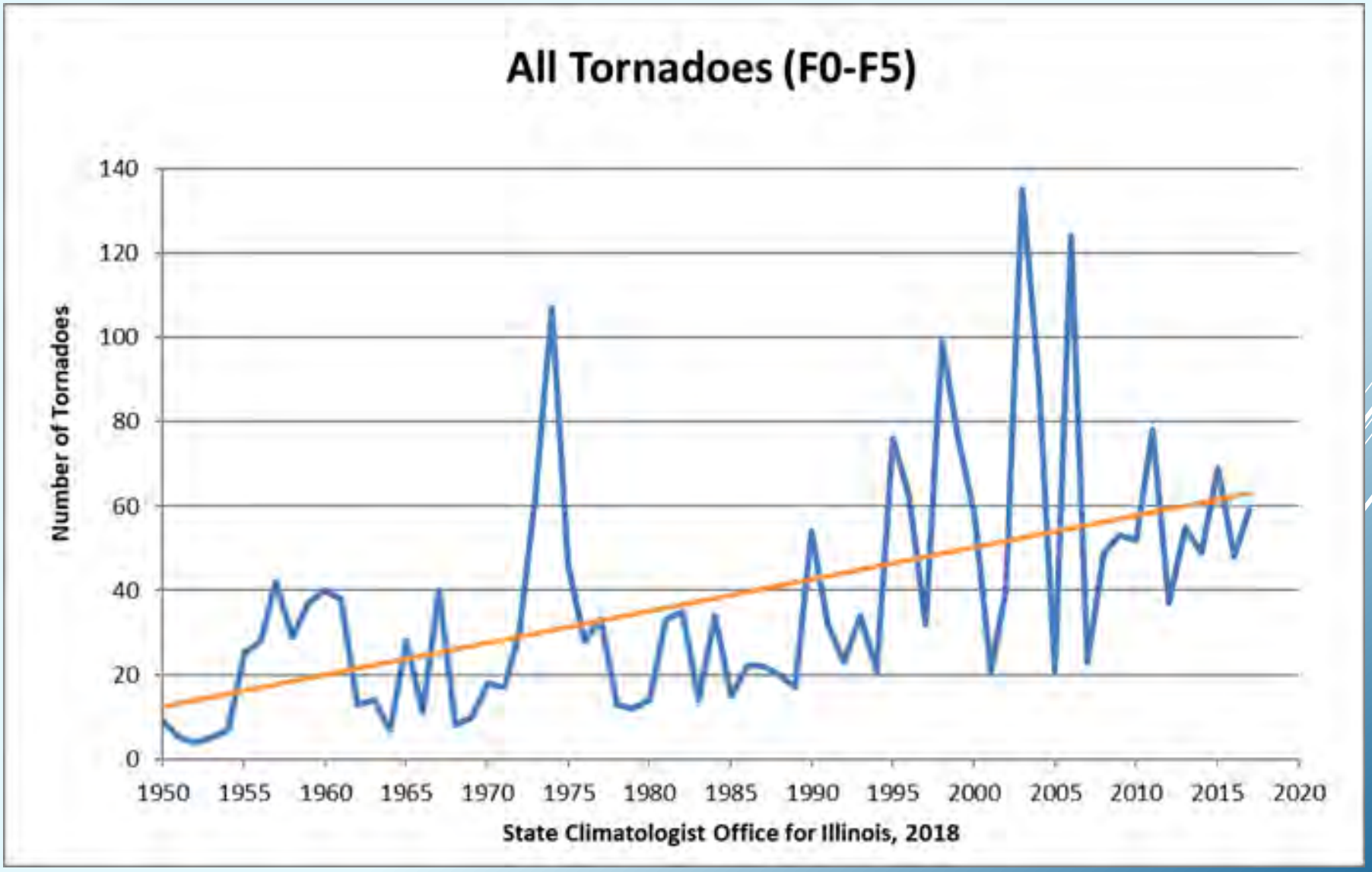


The oceans are warmer because of climate change.

Warmer and moister conditions are the key for unstable air.

Unstable low-level air creates convection and thunderstorms.

https://www.scientificamerican.com/article/kevin-trenberth-on-climate-change-and-tornadoes/


All Tornadoes (F0-F5)
Number of Tornadoes
140
120
100
80
60
40
20
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
State Climatologist Office for Illinois, 2018

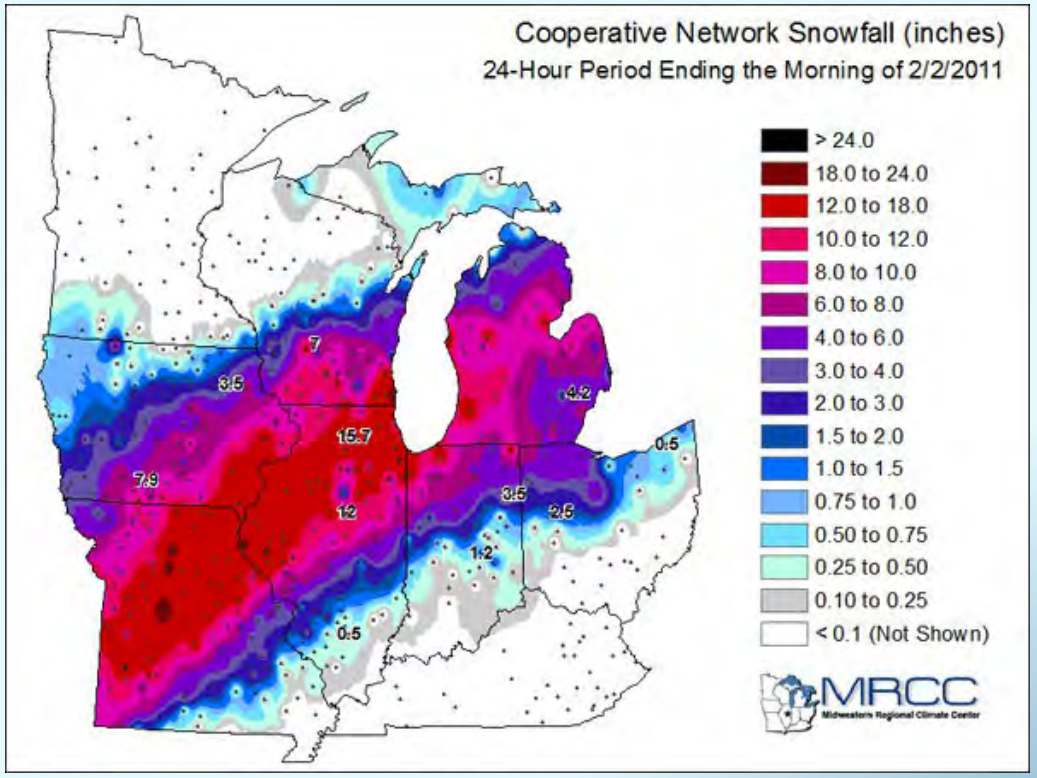
Heavy seasonal snow and extreme snowstorms continue to occur with great frequency as the climate has changed.

The frequency of extreme snowstorms in the eastern two-thirds of the contiguous United States has increased over the past century.

Approximately twice as many extreme U.S. snowstorms occurred in the latter half of the 20th century than the first.

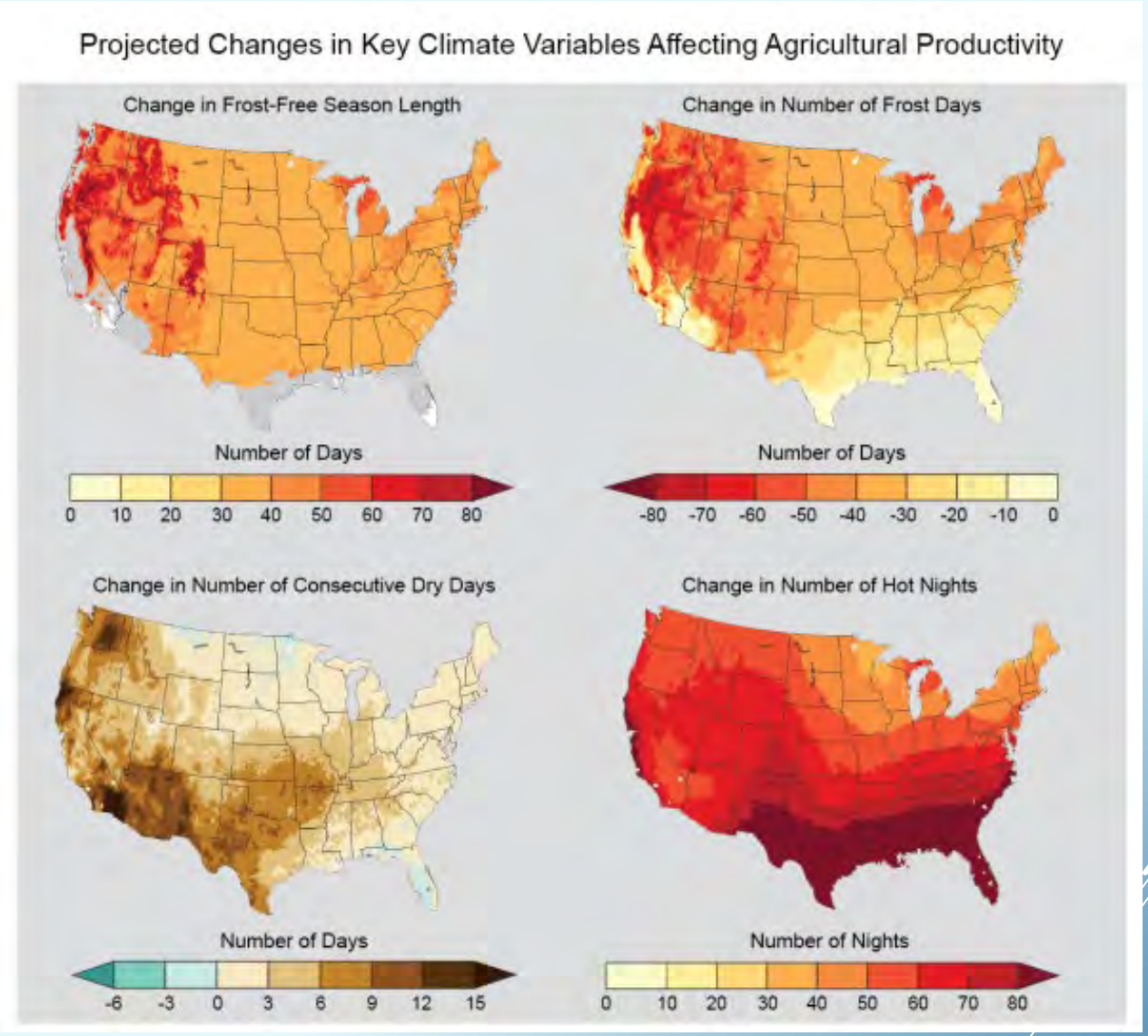
https://www.ncdc.noaa.gov/news/climate-change-and-extreme-snow-us

February 1 to 3, 2011, Illinois was hit by one of the most powerful winter storms in history. The greatest snow accumulation was in Antioch with 27 inches of snow.



Longer growing seasons and rising carbon dioxide levels will increase yields of some crops, but these benefits will be progressively offset by extreme weather events.

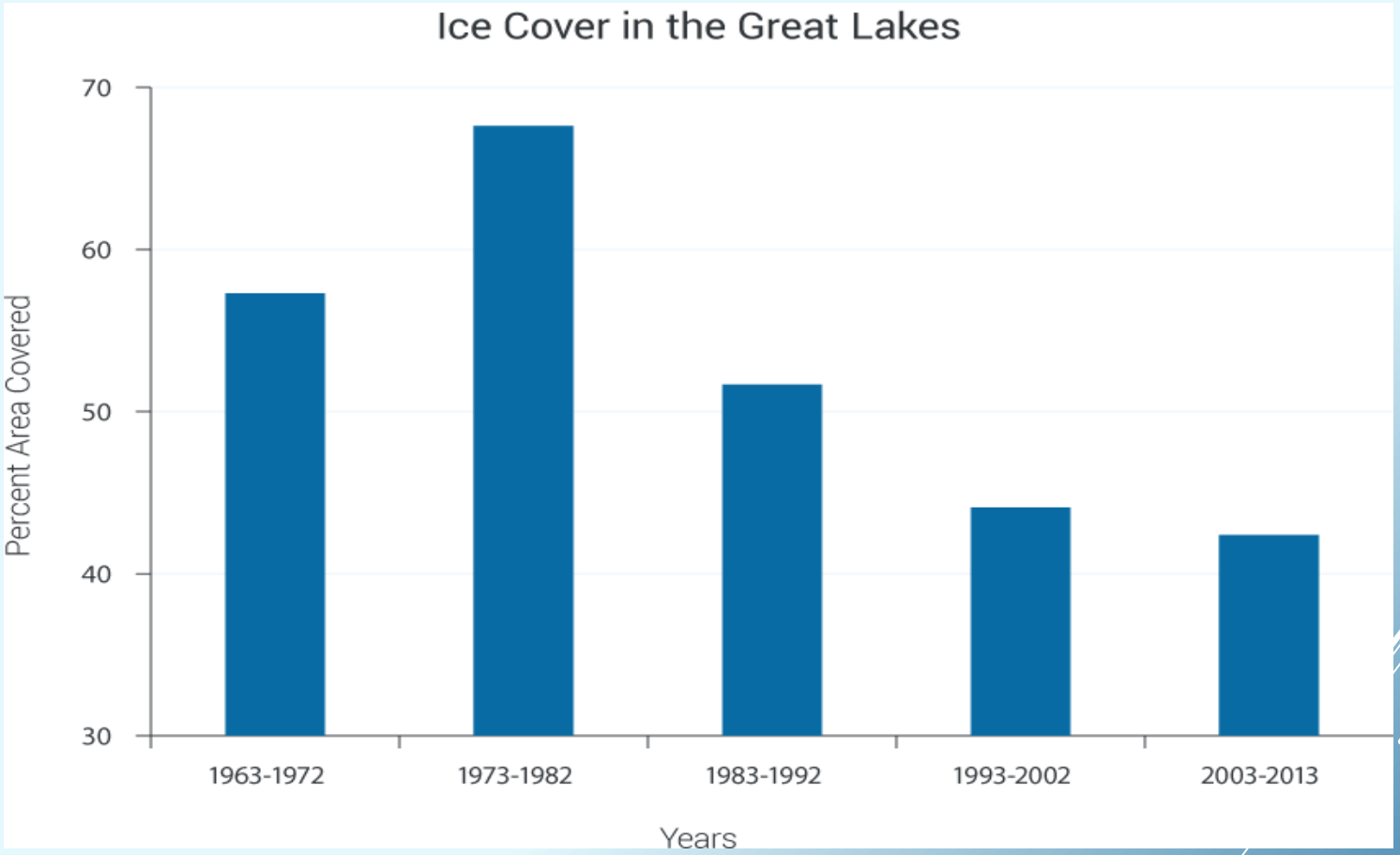
BUT stresses associated with climate change are expected to decrease agricultural productivity.



https://www.globalchange.gov/browse/multimedia/projected-changes-key-climate-variables-affecting-agricultural-productivity

- The Great Lakes contain 21% of the world's fresh water.
- About 34 million people rely on them for drinking water, jobs, recreation and their way of life.
- Great Lakes ice coverage has declined substantially.
- Less ice, coupled with more frequent and intense storms, leaves shores vulnerable to erosion and flooding and could harm property and fish habitat.

http://elpc.org/wp-content/uploads/2019/03/Executive-Summary-GLClimateChange.pdf



https://nca2014.globalchange.gov/highlights/regions/midwest

https://dataintheclassroom.noaa.gov/

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Satellite and Information Service

Data in the Classroom

Home El Nino Sea Level

In Each Module

The Data in the Classroom Team, comprised of education and technology experts, along with teachers, wants to make each of these resources as easy to use for you and your classroom as possible.

Each module is built with the same structure and sets of resources:

Story Map

The StoryMap activity works with any display device (desktop, laptop, tablet) connected to the internet. Within each StoryMap, there are tabs for each Activity Level (1-5), Get Data tools, and Teacher Resources. Please visit the Using the Technology page for a better understanding of the StoryMaps

Teacher's Guide

A Teacher's Guide (PDF) that goes through each activity in great detail, provides all of the information that you'll need to work through any of the activities with either the StoryMap or the printable resources.

Supplemental PowerPoint

Since not every classroom can be fully "wired" there are PowerPoint files that have each map or image used in the online activity as a printable version.

Student Activity Sheets

Student Activity sheets can be used to log data observations and analysis for each of the modules and activity levels.

Science Education Standards

Data in the Classroom is committed to developing resources that support the needs of educators. Key to the framework's design is three dimensional learning that includes science or engineering practice (SEP), a disciplinary core idea (DCI), and a crosscutting concept (CC). Learn more about how each module specifically relates to the Framework, as well as the Next Generation Science Standards, by visiting the Teacher Guide section of any of the online modules.

Invention Level: Invention is the highest cognitive level. Exercises need to be designed where pedagogy and technology are integrated simultaneously. This is where the inquiry approach can be fully implemented. This area is very student driven.

Interactivity Level: This level features the use of complex technology interactions. Here problem-solving techniques are introduced that can be very student directed. Tools are needed for students to analyze data and discuss findings.

Adaptation Level: Students use portal tools to play and practice what they know. These interactions can be student-directed.

Adoption Level: Many teachers appreciate having prescriptive approaches to utilizing online tools. We recommend some form of drill and practice exercises that are predictable to teachers and will be available for them to share with their students. Once understood teachers can move to the next level of online interactivity and teacher technology inclusion.

Entry Level: The developers are making the basic assumption that first-time users of a new portal are at an entry level and need direct guidance in how to use the portal and demonstration site. This level of interaction is very teacher directed. Once teachers learn how to use the site they are ready to skip this level and move on to more complex levels. The Entry Level provides teachers with a teach-back system to help their students enter into the portal and its use.

Data in the Classroom

Home El Nino Sea Level

UNDERSTANDING SEA LEVEL

Scientists know that sea level is rising, and that we experience some of these impacts as more frequent and intense storm surge and coastal flooding events. Using data from NOAA's satellites and coastal stations, you will do the analysis to see sea level changing. Explore our Sea Level activity and download our Teacher's Guide.

LAUNCH THE ACTIVITY

Teaching Resources

- Teacher's Guide
- Supplemental PowerPoint
- Student Activity Sheets
- Science Standards

Materials Needed

	Computer with an internet connection	Student Worksheets	Additional Activities in Teacher's Guide
Level One		●	
Level Two		●	●
Level Three	●	●	
Level Four	●	●	
Level Five	●	●	

Science and Engineering Practices (SEPs)	Middle School SEP	How the SEP Is Addressed by the Module	Level				
			1	2	3	4	5
Analyzing and Interpreting Data	Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2).	Students compare their data assessments of typical tidal range at a given location, from Level 3, with tide data during a storm event to determine the effect of storms on coastal sea level				x	x
Developing and Using Models	Develop and use a model to describe phenomena. (MS-ESS2-4)	Students access and analyze NOAA data tools (data being used as a basis for models) to identify and explain changes in sea level resulting from winds and tides. Students use tide data to construct a model (diagram) to describe the approximate orientation of the moon relative to the earth.		x	x		

Disciplinary Core Ideas (DCIs)	Middle School DCI	How the DCI Is Addressed by the Module	Level				
			1	2	3	4	5
The Roles of Water in Earth's Surface Processes	**MS-ESS2.C:** Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)	Students understand that sea level continually fluctuates due to variations in wind, currents and water density (all by-products of the sun's energy) and tides (caused by gravitational forces).	x	x	x		
Natural Hazards	**MS-ESS3.B:** Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	Students optionally analyze and interpret satellite data to investigate the history of hurricanes and related sea surface height deviations in the Gulf of Mexico.					x

Crosscutting Concepts (CCCs)	Middle School CCC	How the CCC Is Addressed by the Module	Level				
			1	2	3	4	5
Patterns	Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2).	Students use tide graphs (and optionally satellite maps) to identify sea level patterns associated with storms.				x	x
Energy and Matter	Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)	Students understand that sea level continually fluctuates due to variations in wind, currents and water density (all by-products of the sun's energy) and tides (caused by gravitational forces).	x	x	x		

National Oceanic and Atmospheric Administration
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Satellite and Information Service

Data in the Classroom

Home | El Nino | Sea Level | Coral Bleaching

INVESTIGATING EL NIÑO

People blame El Niño for all kinds of abnormal weather. One of the ways to detect an El Niño event is to look at sea surface temperature (SST). By observing SST through graphs and maps, you can track the growth of plant life and even begin to predict future El Niño events. Explore our El Niño activity and download our Teacher's Guide.

LAUNCH THE ACTIVITY

Understanding El Niño Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teachers Guide

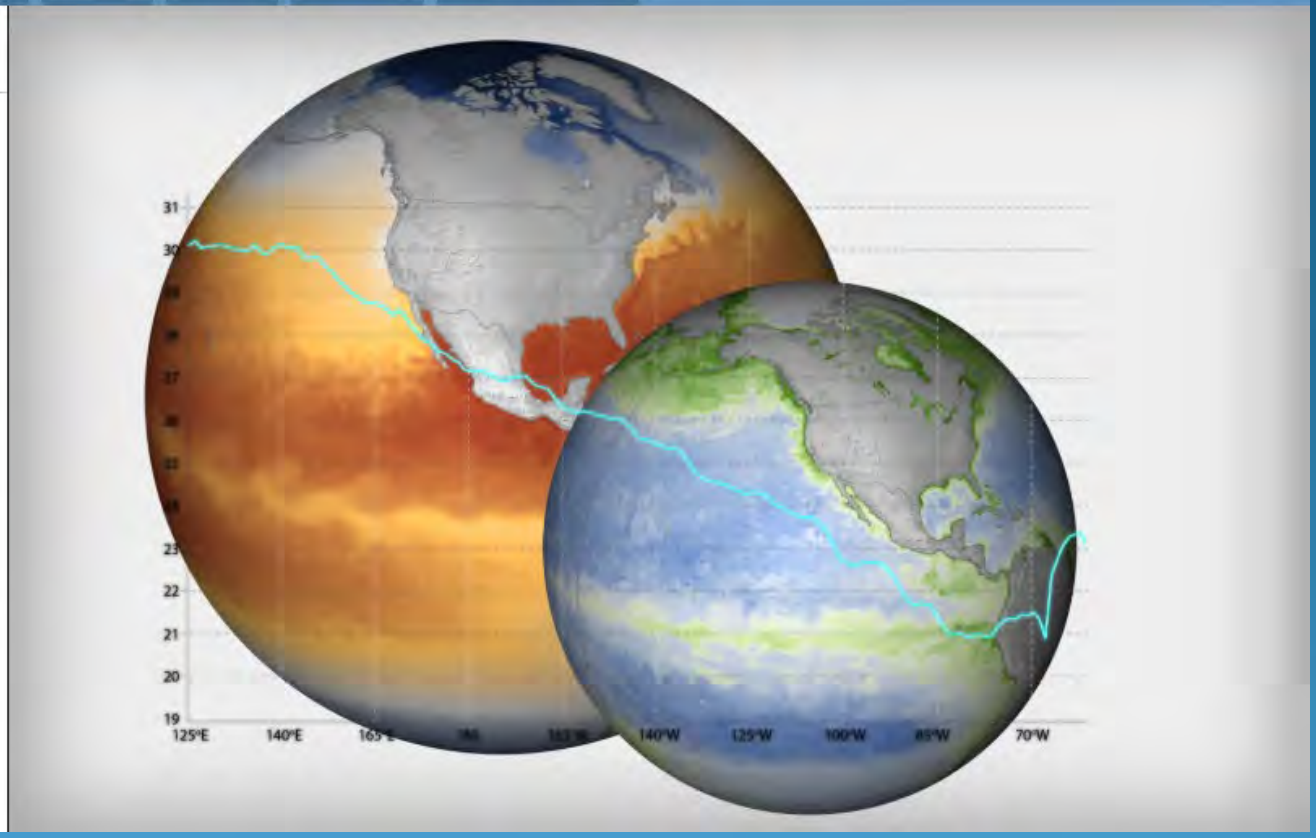
Introduction

People blame El Niño for all kinds of abnormal weather. But how does El Niño really work?

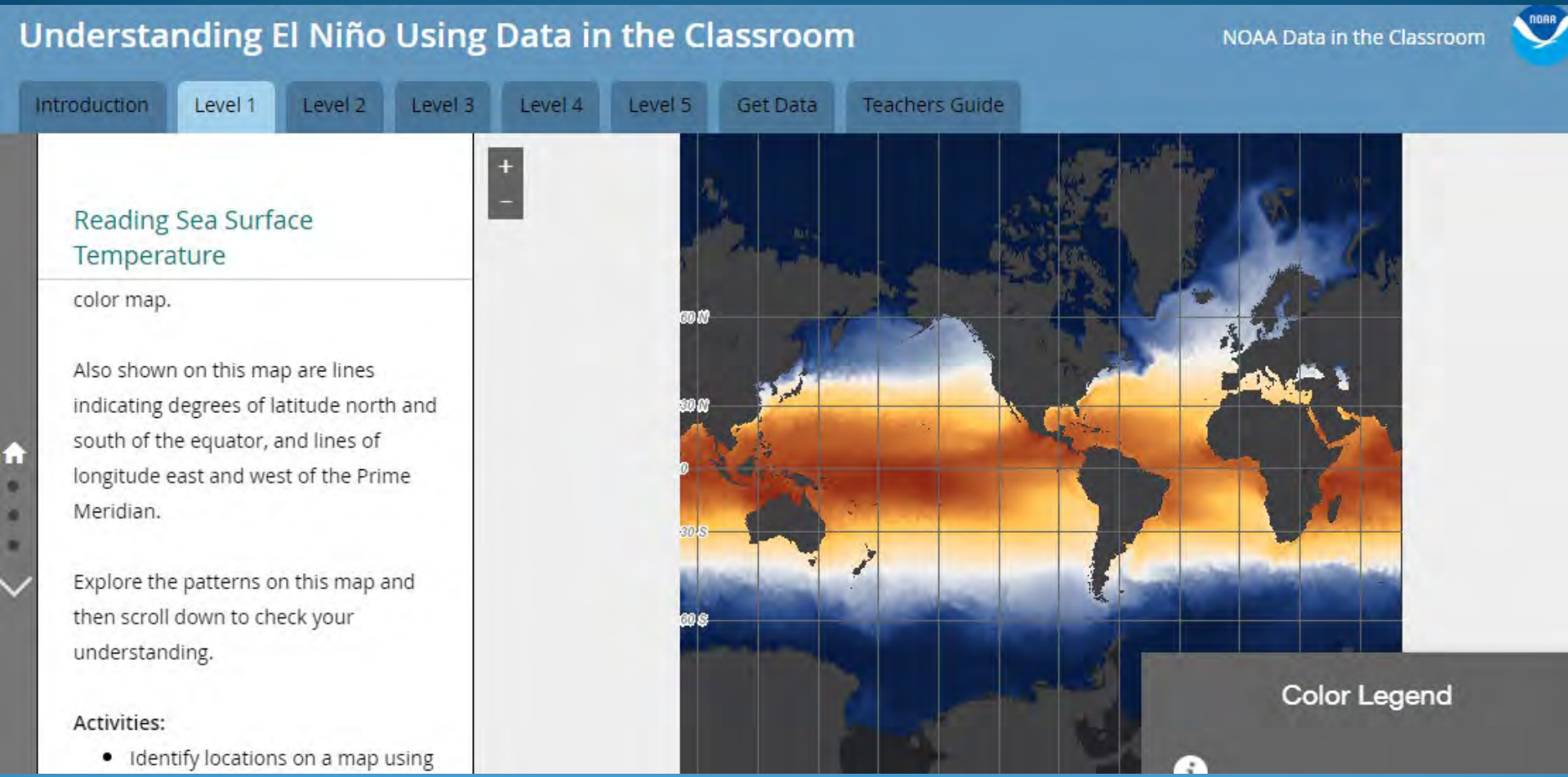
This activity uses a series of interactive web maps, apps, and high resolution images to help you learn about El Niño using real data from NOAA.

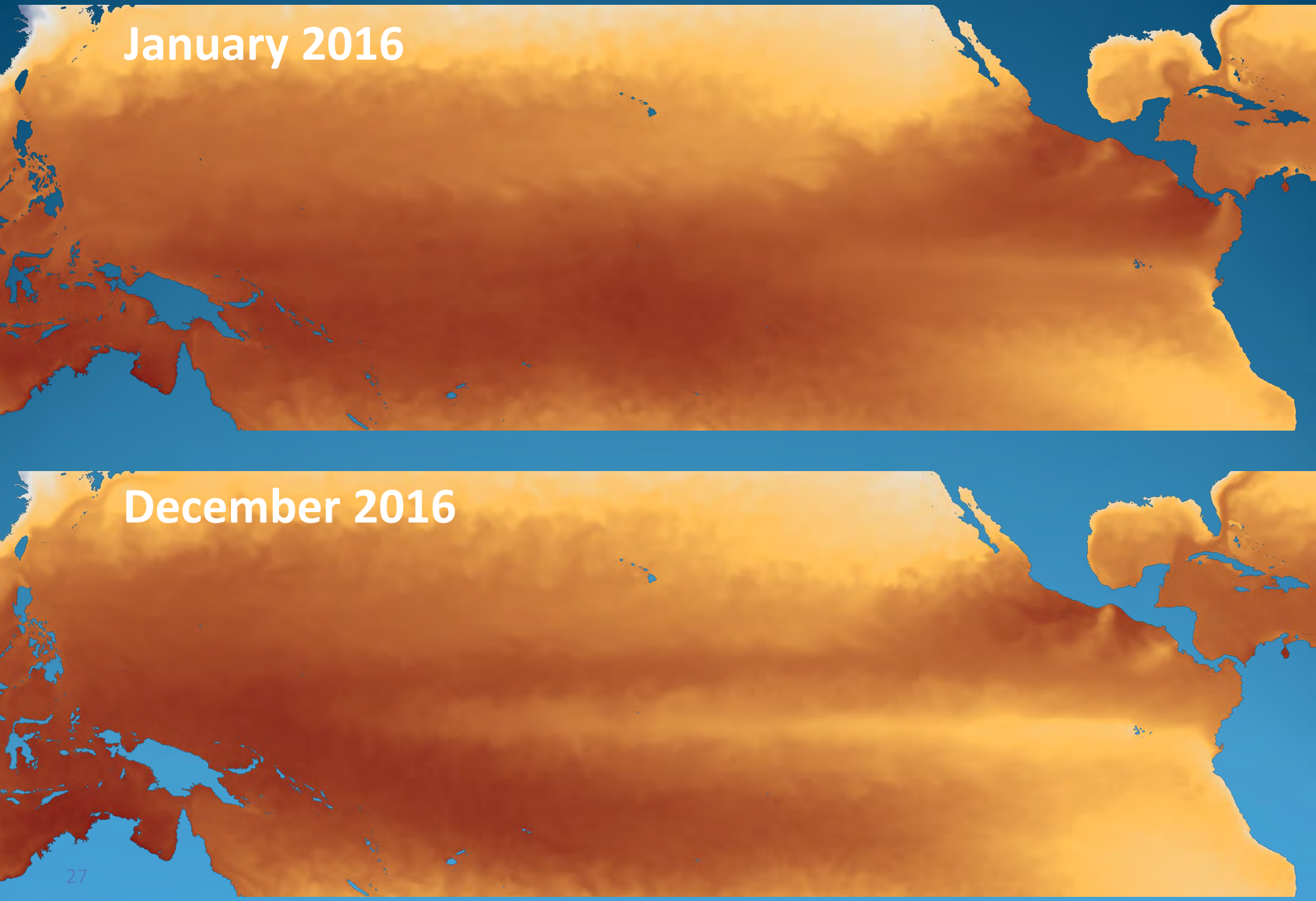
Work through Levels 1-5, or explore the data on your own using the NOAA data tools.

Teachers: These online activities support an in-depth curriculum module on El Niño for middle school students and beyond. To



Level 1


Understanding El Niño Using Data in the Classroom
NOAA Data in the Classroom
Introduction
Level 1
Level 2
Level 3
Level 4
Level 5
Get Data
Teachers Guide
Reading Sea Surface Temperature
color map.
Also shown on this map are lines indicating degrees of latitude north and south of the equator, and lines of longitude east and west of the Prime Meridian.
Explore the patterns on this map and then scroll down to check your understanding.
Activities:
Identify locations on a map using
60 N
30 N
0
30 S
60 S
Color Legend


January 2016
December 2016

Level 4

Understanding El Niño Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teachers Guide

Relating SST to Productivity

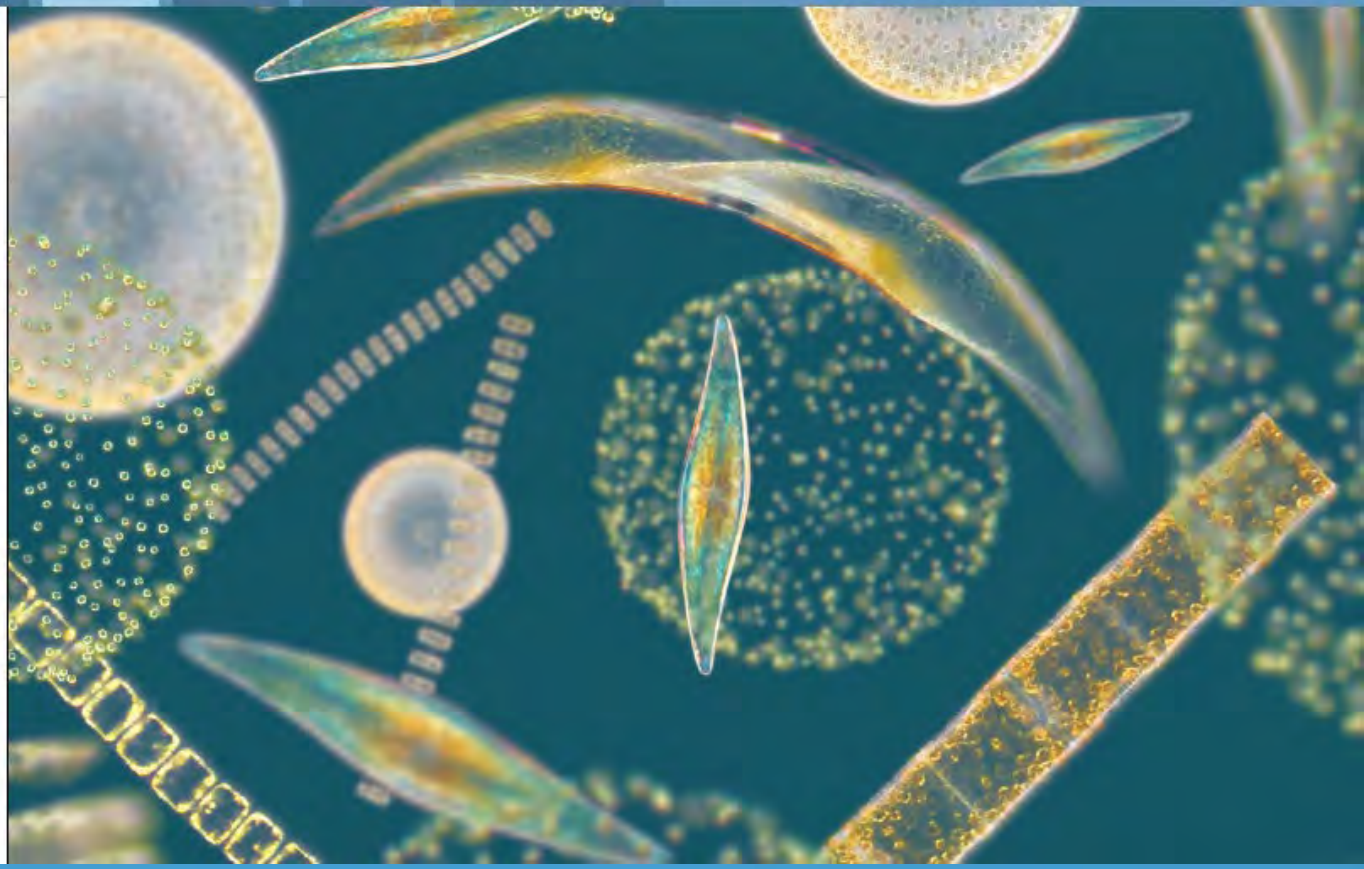
Introduction

Objective

Students will examine the relationship between SST and chlorophyll a to understand how El Niño affects productivity in the ocean.

Background

Phytoplankton are microscopic plants that live near the surface of the ocean and provide food for larger organisms. They form the base of the food chain.



Level 5

Understanding El Niño Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teachers Guide

Designing Your Own Investigation

Introduction

Objective

Students will design an investigation using real data on El Niño to try to answer a research question of their choosing.

Background

Students will design an investigation

Impacts of El Nino

- Major events in 1972-73, 1982-83, 1997-98, and 2015-16
- Above-normal temperatures to much of the Midwest region, particularly across the northern states.
- Extreme cold weather may be milder and less frequent.
- May bring drier conditions to eastern portions of the Midwest.
- Past strong El Niño events since the 1950s suggest a lower risk of extreme precipitation events capable of producing widespread river flooding.

File Edit View History Bookmarks Tools Help

Inbox - psteffen@imsa.edu - | Coral Bleaching | NOAA Data | elnino events - Google Search

https://datainttheclassroom.noaa.gov/cont

Search

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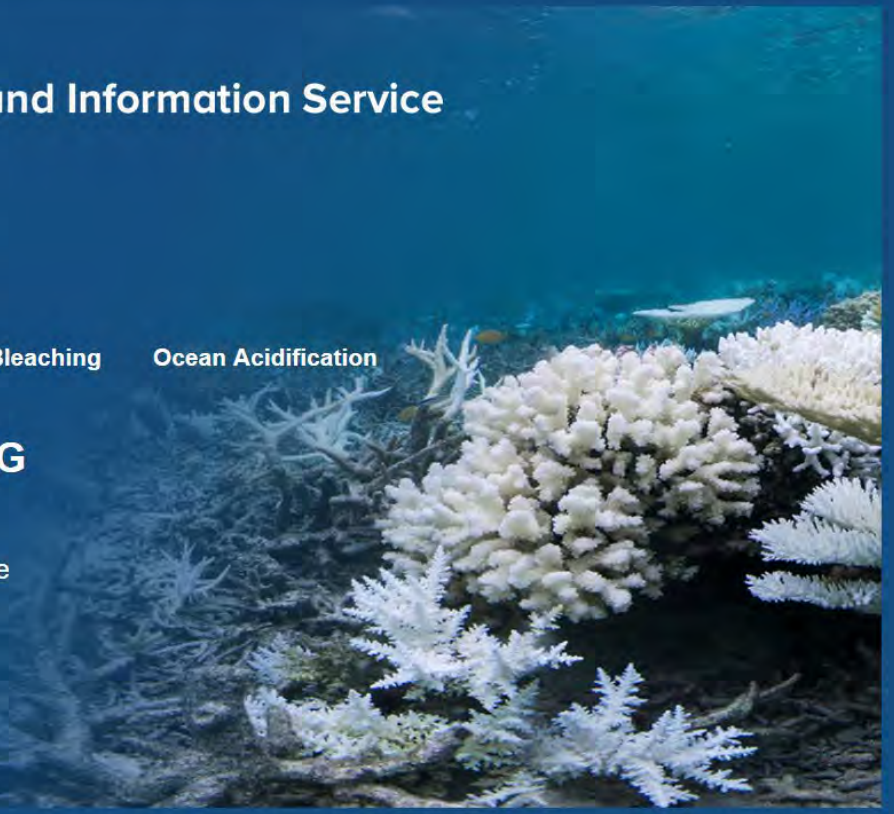
U.S. Department of Commerce

Satellite and Information Service

Data in the Classroom

Home El Nino Sea Level Water Quality Coral Bleaching Ocean Acidification

INVESTIGATING CORAL BLEACHING



Coral reefs are one of the most diverse ecosystems on the planet. In this module, students will use real data to investigate the consequences of rising sea surface temperature on coral reefs. They will also consider the importance of coral reefs in their own lives. Explore our Coral Bleaching activity and download our Teacher's Guide.

Coral Reef Locations and Temperature

Coral Reef Habitat and Range

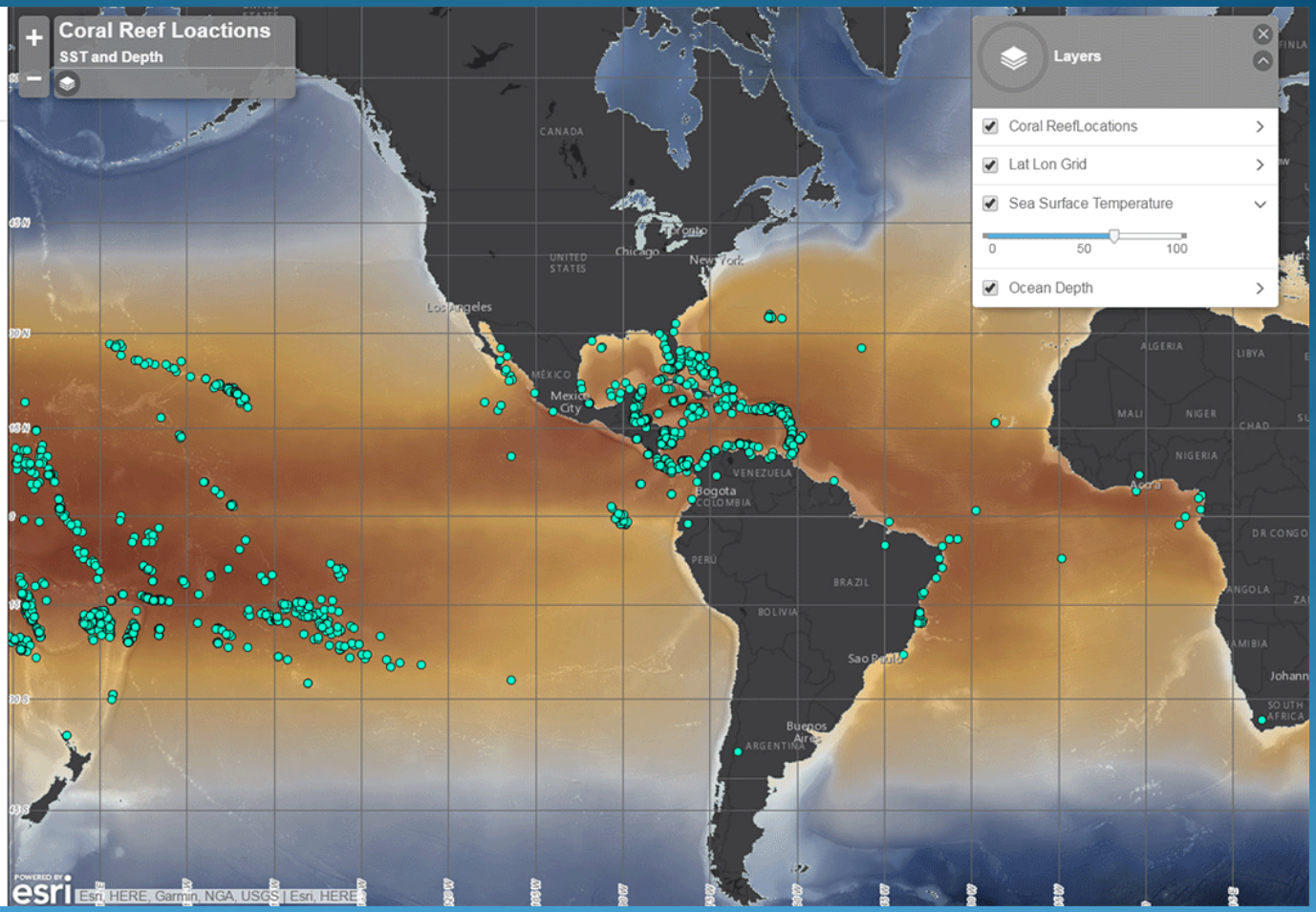
Building upon the earlier maps, analyze this map that combines coral reef locations, average SST, and ocean depth, along with a grid of latitudes and longitudes.

In the Layers box at the upper right, you can turn on/off each layer, or click the > next to the layer name and a slider will appear that allows you to change the transparency of a layer.

Question 4: Which best describes the range of coral reef habitats?

- Coral reefs occur anywhere that the SST is above 20°C
- Coral reefs occur at any temperature that is close to land
- Coral reefs occur in warm, deep waters between 30°N latitude and 30°S latitude
- Coral reefs occur in warm, shallow waters between 30°N latitude and 30°S latitude

Check my answer



https://datainthecclassroom.noaa.gov/

File Edit View History Bookmarks Tools Help

Investigating Coral Bleaching U

https://portal.nnvl.noaa.gov/arcgis/apps/

Search

Investigating Coral Bleaching Using Data in the Classroom

NOAA Data in the Classroom

Introduction | Level 1 | Level 2 | Level 3 | Level 4 | Level 5 | Get Data | Teacher's Guide

Monitoring Coral Reefs in the Field

Introduction

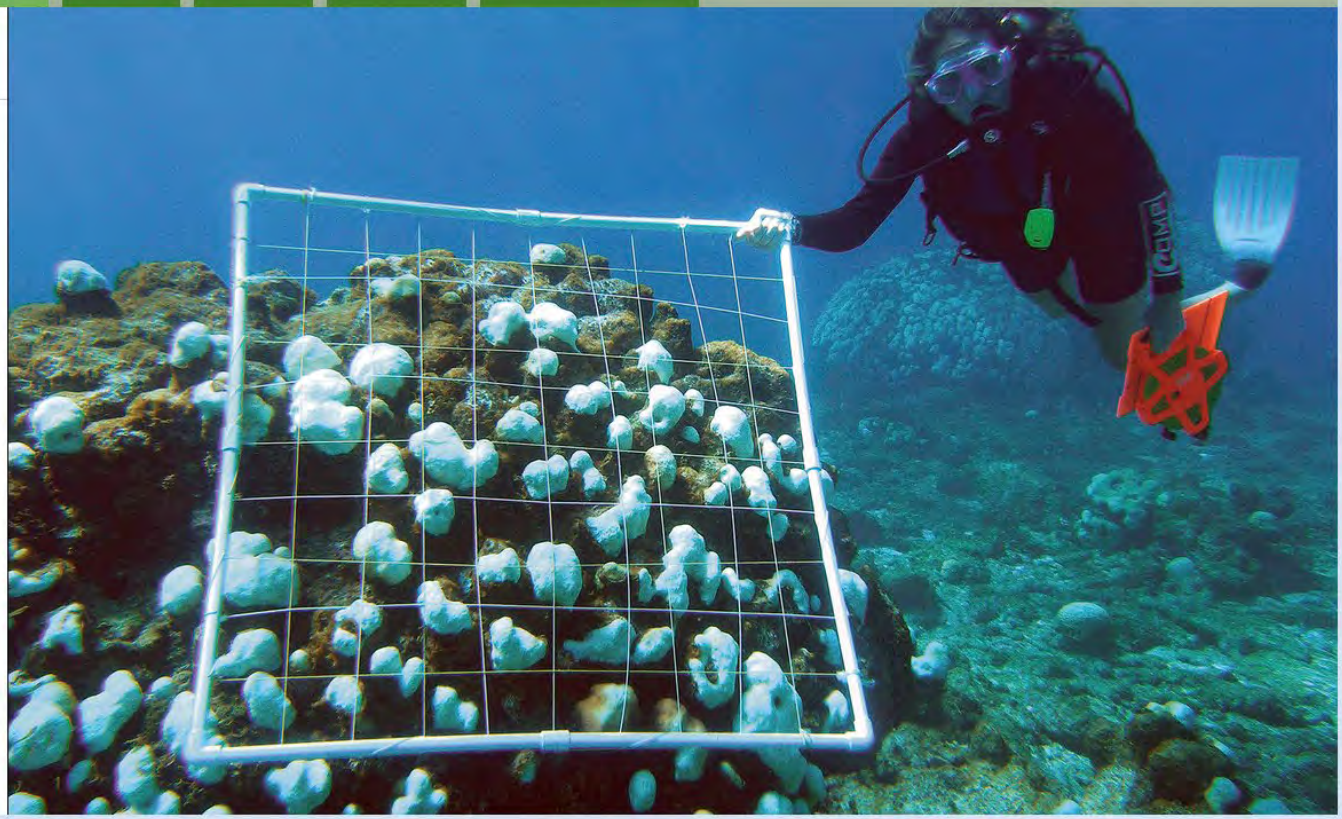
Objectives

Students will learn how to identify coral bleaching and understand how scientists measure bleaching at reefs around the world.

Summary

Grade Level: 6-8

Teaching time: 45 minutes

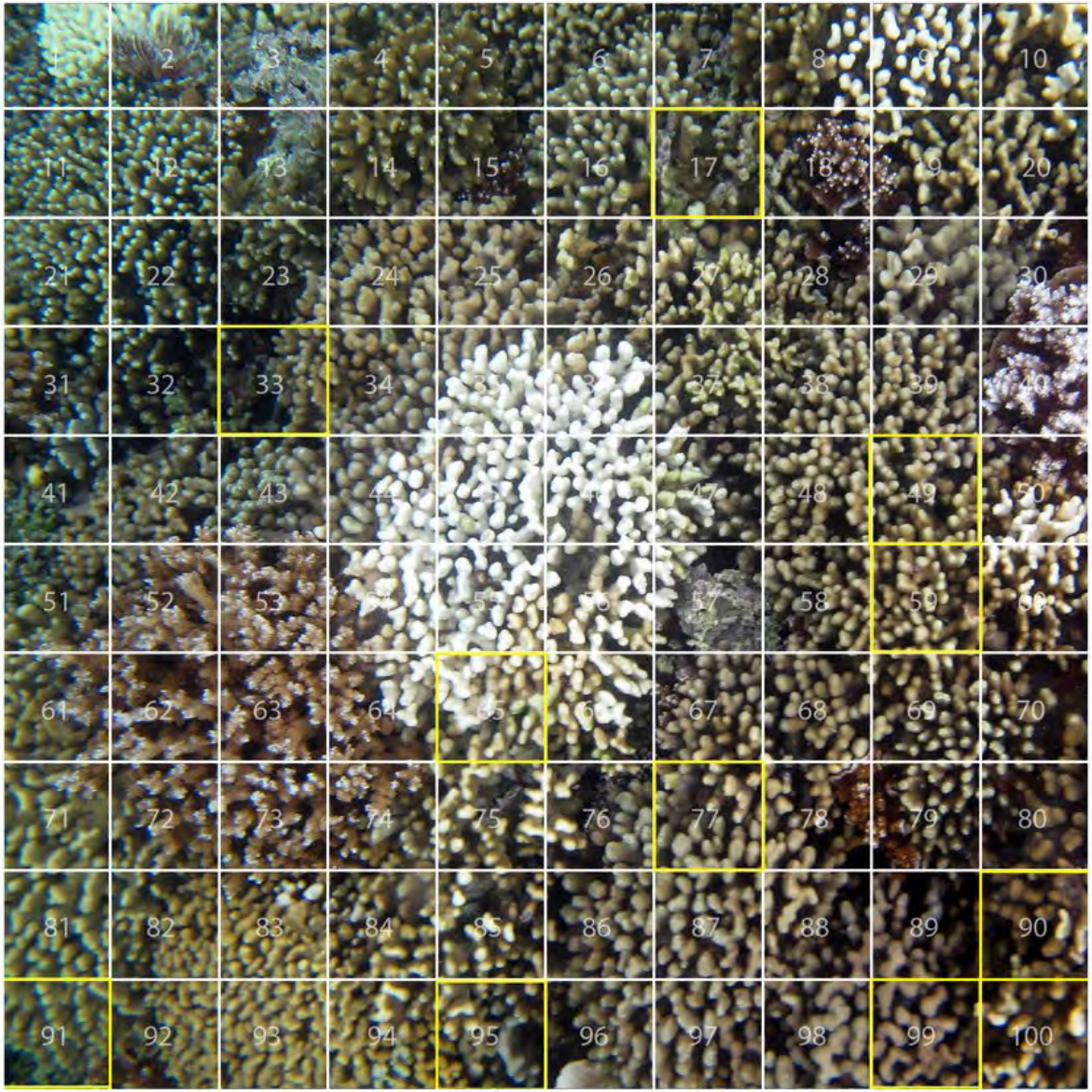


History Bookmarks Tools Help

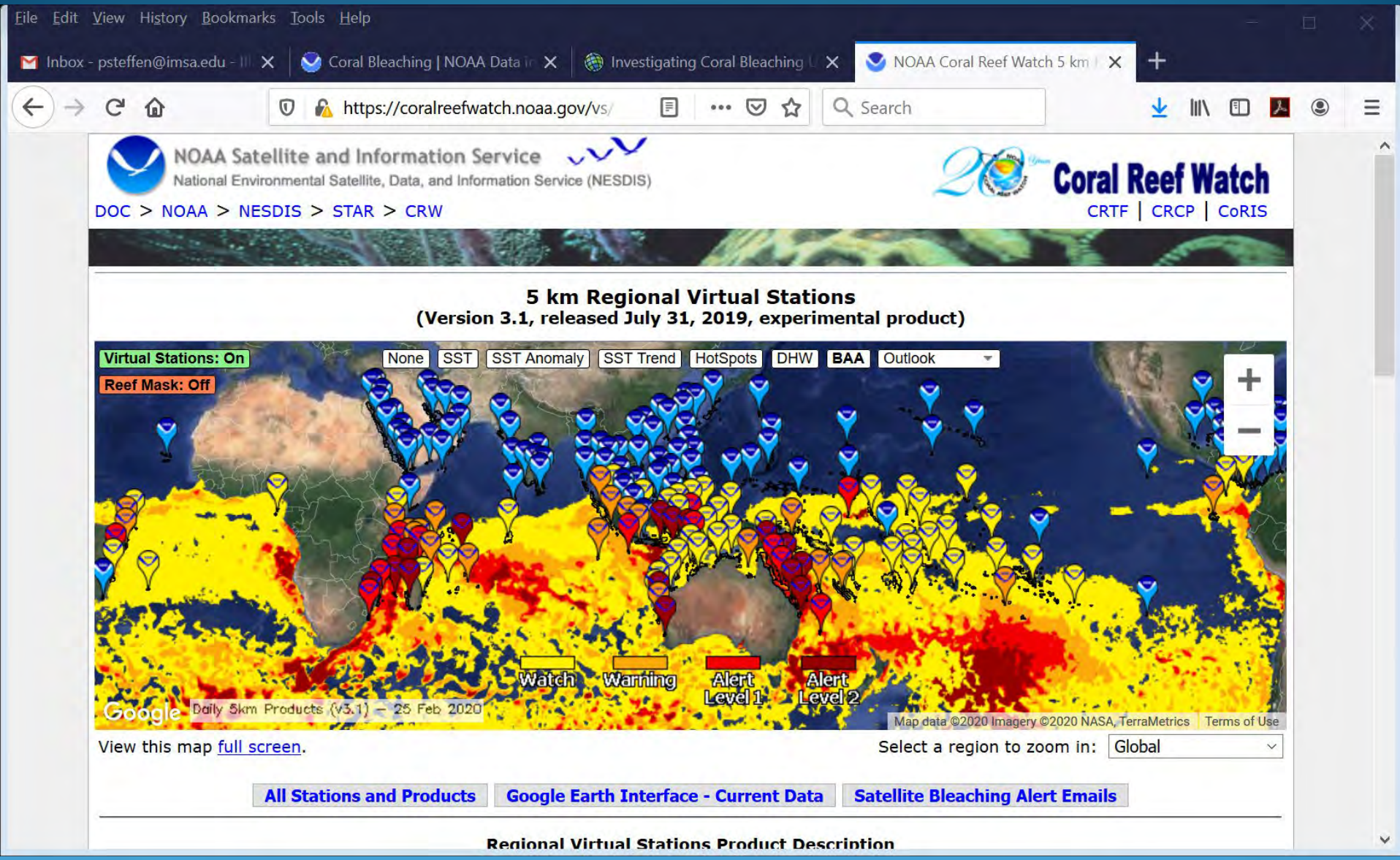
Coral Bleaching U | Q5.jpg (JPEG Image, 2000 × 2000 p

https://www.nnvl.noaa.gov/StoryMaps/DI

Search

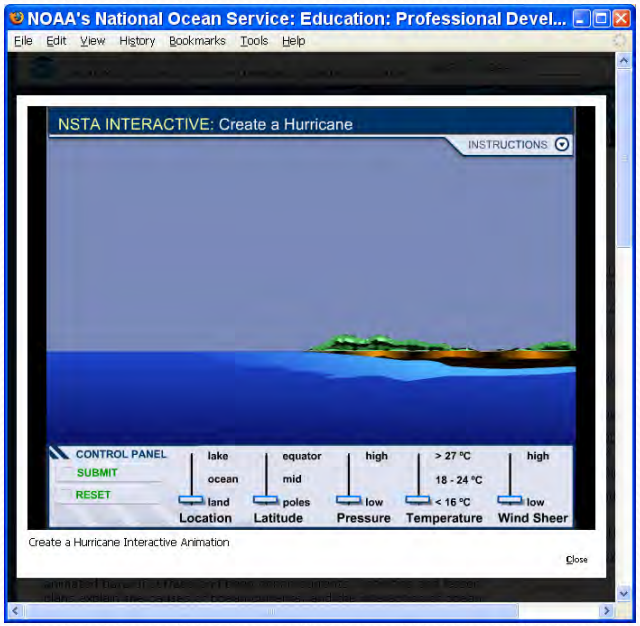


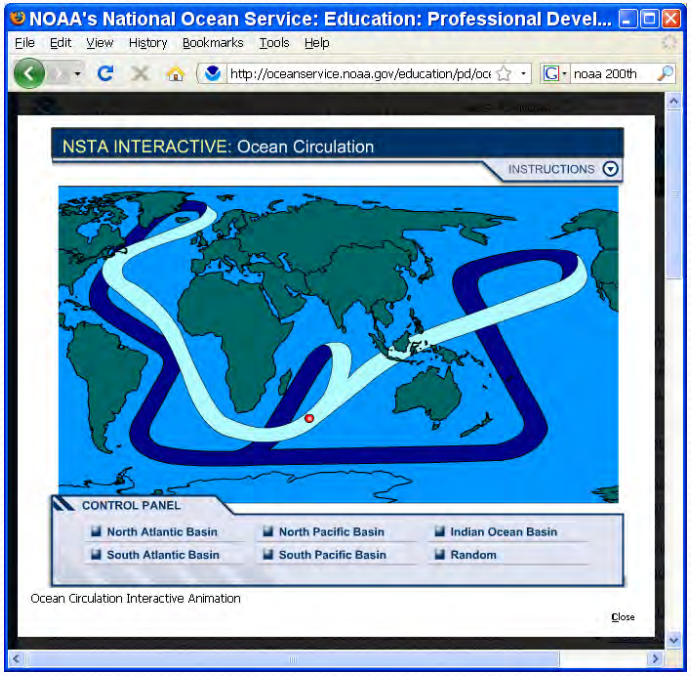
https://coralreefwatch.noaa.gov/vs/map.php?lat=2&lng=-28&zoom_level=3

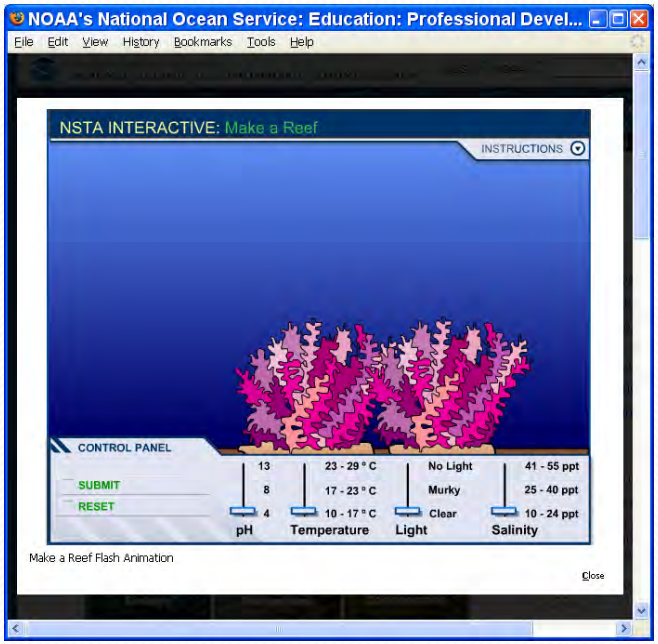


Interactive simulations

- Coral reef
- Climate
- Ocean Circulation

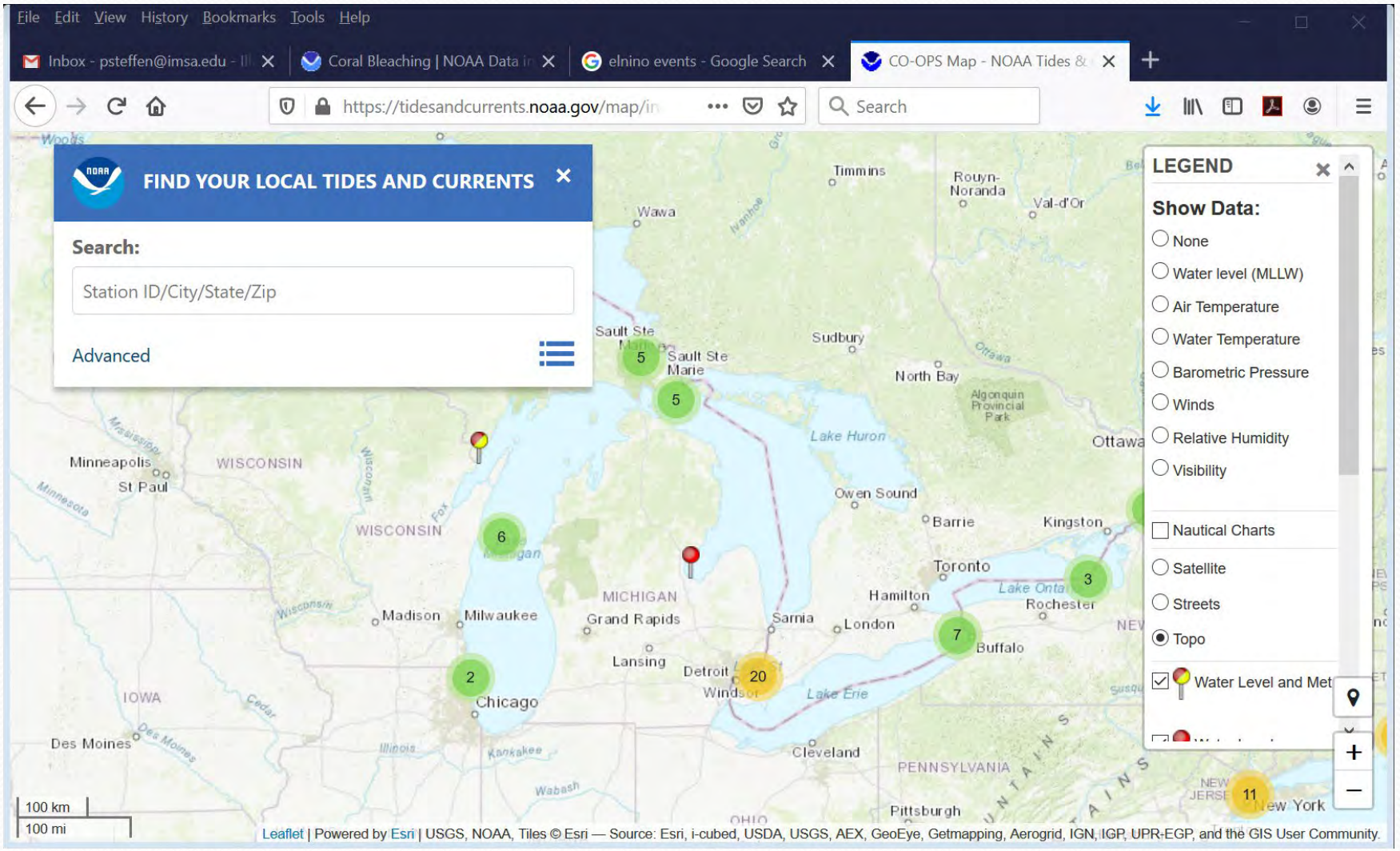






http://oceanservice.noaa.gov/education/pd/oceans_weather_climate/welcome.html

https://tidesandcurrents.noaa.gov/map/index.html?region=Lake%20Michigan

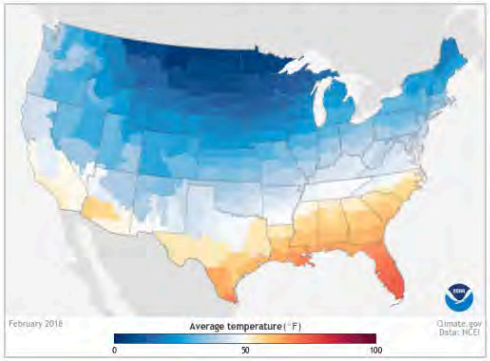


Observed Sea Level Measurements from Tide Gauges

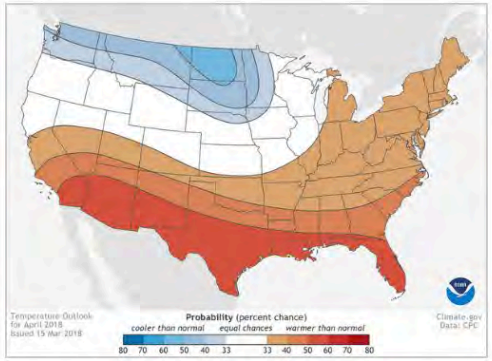
- Calculation of **relative sea level trends and analyses** at U.S. and Global stations, for **Local, Regional & Global trend comparison**

http://tidesandcurrents.noaa.gov/sltrends/index.shtml

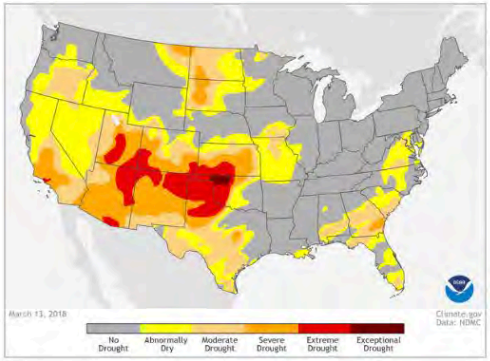
Data Snapshots: Reusable Climate Maps



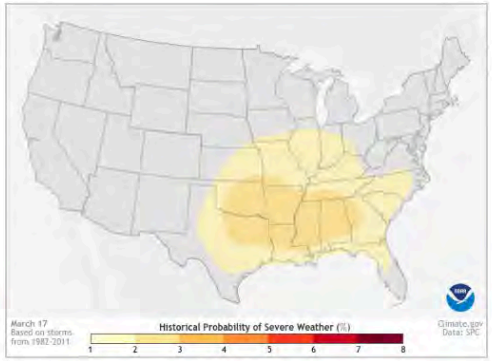
Average Monthly Temperature



Monthly Temperature Outlook



Drought Monitor



Severe Weather Climatology

Explore a range of easy-to-understand climate maps in a single interface. Featuring the work of NOAA scientists, each "snapshot" is a public-friendly version of an existing data product.

Browse the Dataset Gallery

This visual catalog with convenient filtering options can help you find the climate data you need. How-to instructions can help you navigate data access tools.

Enter the Dataset Gallery

GIS Data Locator (Advanced Users)

Launch Map Application

Climate Data Primer

Ready to learn some of the basics about climate data? Find out about measuring, modeling, and predicting climate and ways to find and use climate data.

The Primer includes information on instruments used to measure weather and climate; how weather observations relate to climate products; how climate scientists check the quality of observations, and tools you can use for exploring climate data

Open the Primer's table of contents

Recently Updated Datasets

- El Niño-Southern Oscillation Indicators
- Past Weather by Zip Code - Data Table

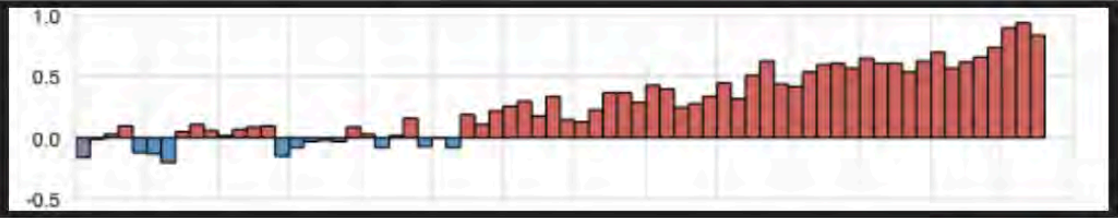
Global Climate Dashboard

▼ Climate Change | ► Climate Variability | ► Climate Projections

Global Average Temperature (˚C)

The temperature near Earth's surface is rising: the bars show each year's average temperature compared to the 20th century average.

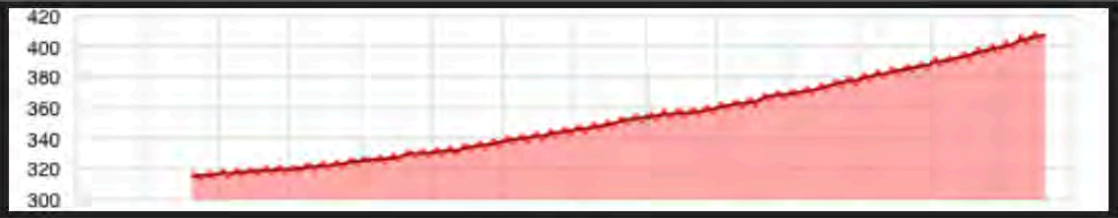
learn more ››



Carbon Dioxide (ppm)

The amount of carbon dioxide in the atmosphere has risen by 25% since 1958, and by about 40% since the Industrial Revolution.

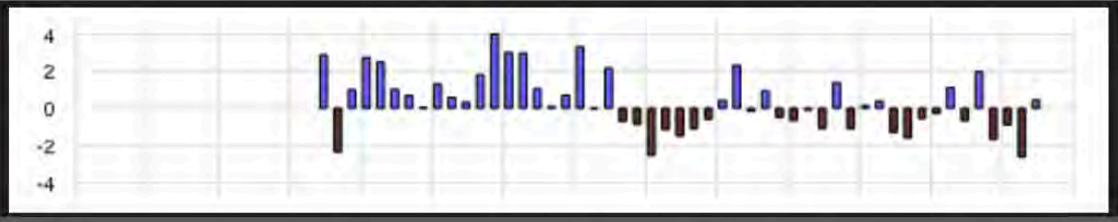
learn more ››

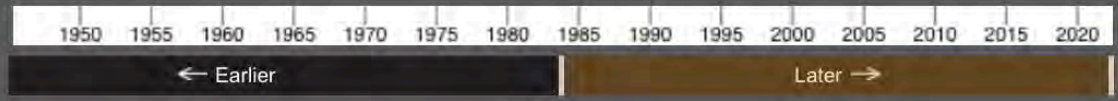


Spring Snow Cover (million km^2)

Snow is melting earlier: each bar shows spring snow cover in the Northern Hemisphere compared to the long-term average.

learn more ››





▲ Temperature | ▲ Carbon Dioxide | ▲ Snow

► Sea Level | ► Arctic Sea Ice | ► Ocean Heat

► Sun's Energy | ► Glaciers | ► Heat-Trapping Gases

Dataset Gallery

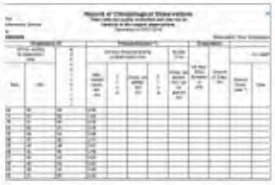
To find datasets of interest, glance through the entries below, enter a search term to the left, or click terms under the filters to refine the list.

Refine by coverage:
- US (34)
- Global (16)
- Regional (1)

Refine by essential climate variables:
- + Atmospheric (33)
- + Terrestrial (10)
- + Oceanic (10)

Refine by data type:
- Land-based station (32)
- Marine / Ocean (10)
- Model (9)
- Satellite (8)
- Severe weather (6)
- Radar (2)
- Paleoclimate (1)

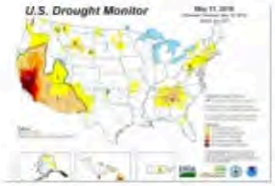
Refine by data format(s):
- txt (ascii) (20)
- csv (19)
- other (12)
- png (12)
- pdf (10)
- xml (7)
- json (5)



Past Weather by Zip Code - Data Table

Climate Data Online - Daily Summaries

How much rain fell over the weekend? What was the temperature over the last few weeks? Tables of daily weather observations can answer these common questions.



Weekly Drought Map

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a weekly map—updated each Thursday—that shows the location and intensity of areas currently experiencing abnormal dryness or drought across the United States.

Record High & Low Daily Temperatures in the U.S. - Graphs and Tabular Data

DayRec: United States Record-Maximum/Minimum Daily Temperatures

Record high and low temperatures generate tremendous interest, largely because of the potential for impacts on human health, the environment, and built infrastructure.

Wind Roses - Charts and Tabular Data

Customized Wind Roses from Hourly Datasets

Wondering which direction the wind was from during your last cold snap, or which summer months usually have a breeze?

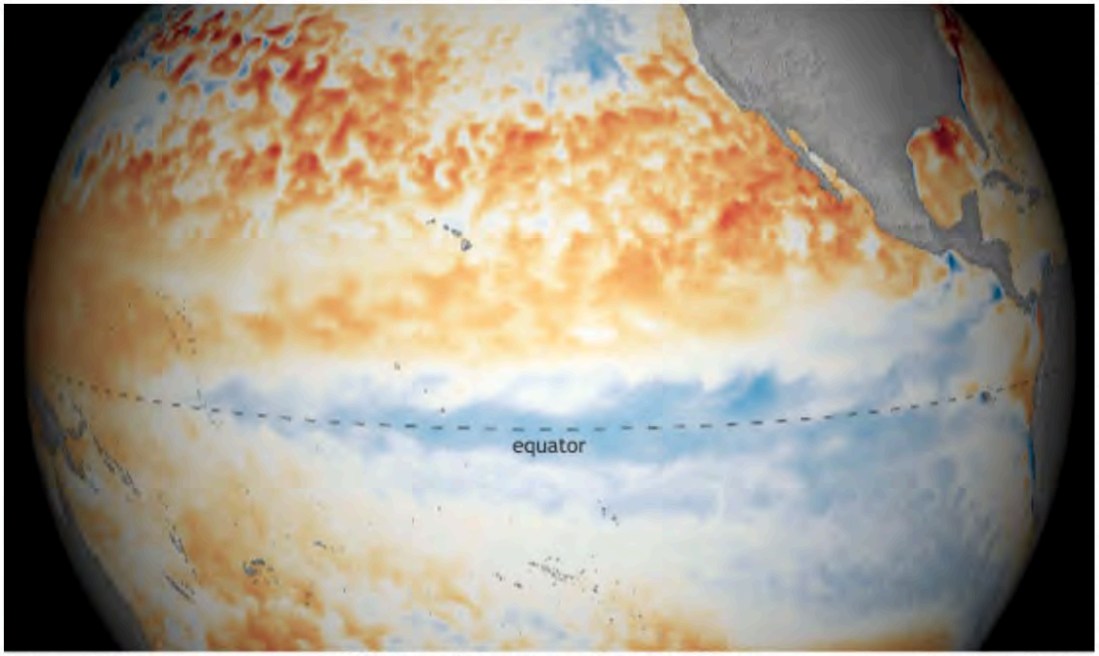
Plan ahead for your BIG birthdays

Explore temperature projections in Climate.gov Data Snapshops

Start thinking now about conditions on your hundredth birthday!

Data Snapshots

Maps | Description



February 2018
compared to 1981-2010

Difference from average temperature (°F)
-9 0 9

Climate.gov/NNVL
Data: Geo-Polar SST

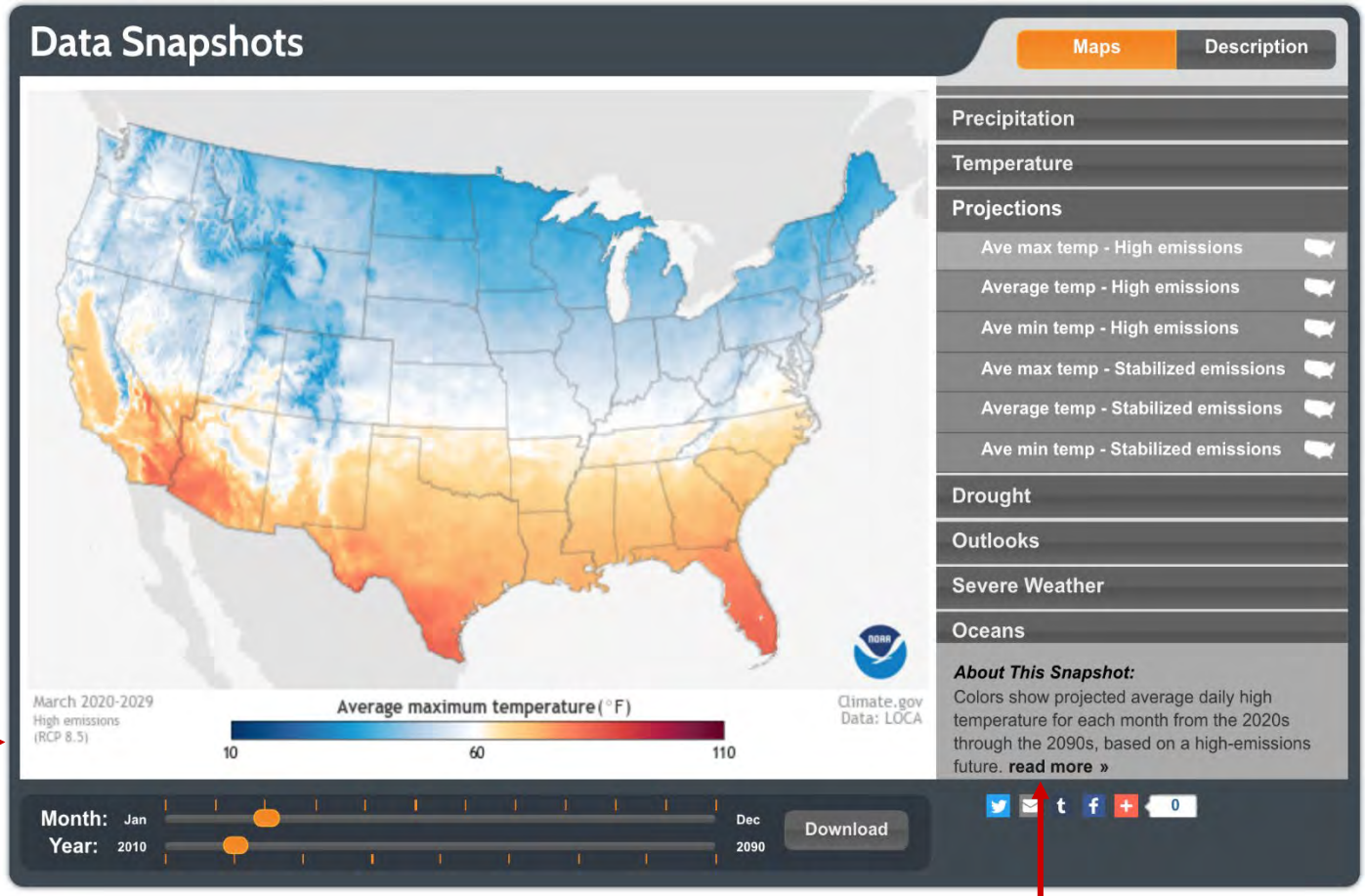
- Precipitation
- Temperature
- Projections
- Drought
- Outlooks
- Severe Weather
- Oceans
  - Sea Surface Temperature (SST)
  - SST anomaly: ENSO monitoring region
  - Monthly SST Anomaly: global
  - Annual SST anomaly: global
  - Ocean Heat Content - Seasonal
  - Ocean Heat Content - Annual

About This Snapshot:
Colors on this map show where and by how much monthly sea surface temperature differed from its 1981 to 2010 average. **read more »**

Month: Jan
Year: 2013 — 2018
2018-02-00

Download

Blue areas show temperatures below 60°F; orange and red show areas above 60°F



Labels show month, decade, and selected future.

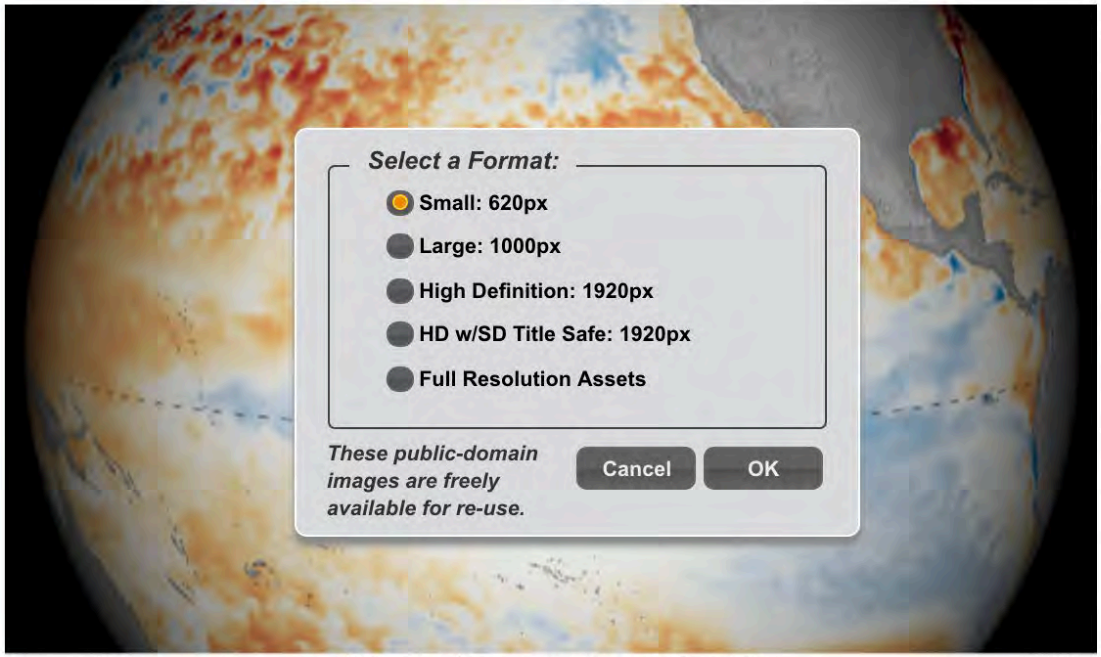
The 1981-2010 image shows conditions from the recent past

2020 to 2090 shows projections from global climate models

Click *read more »* for a fact sheet about the images

Data Snapshots

Maps | Description



- Precipitation
- Temperature
- Projections
- Drought
- Outlooks
- Severe Weather
- Oceans
  - Sea Surface Temperature (SST)
  - SST anomaly: ENSO monitoring region
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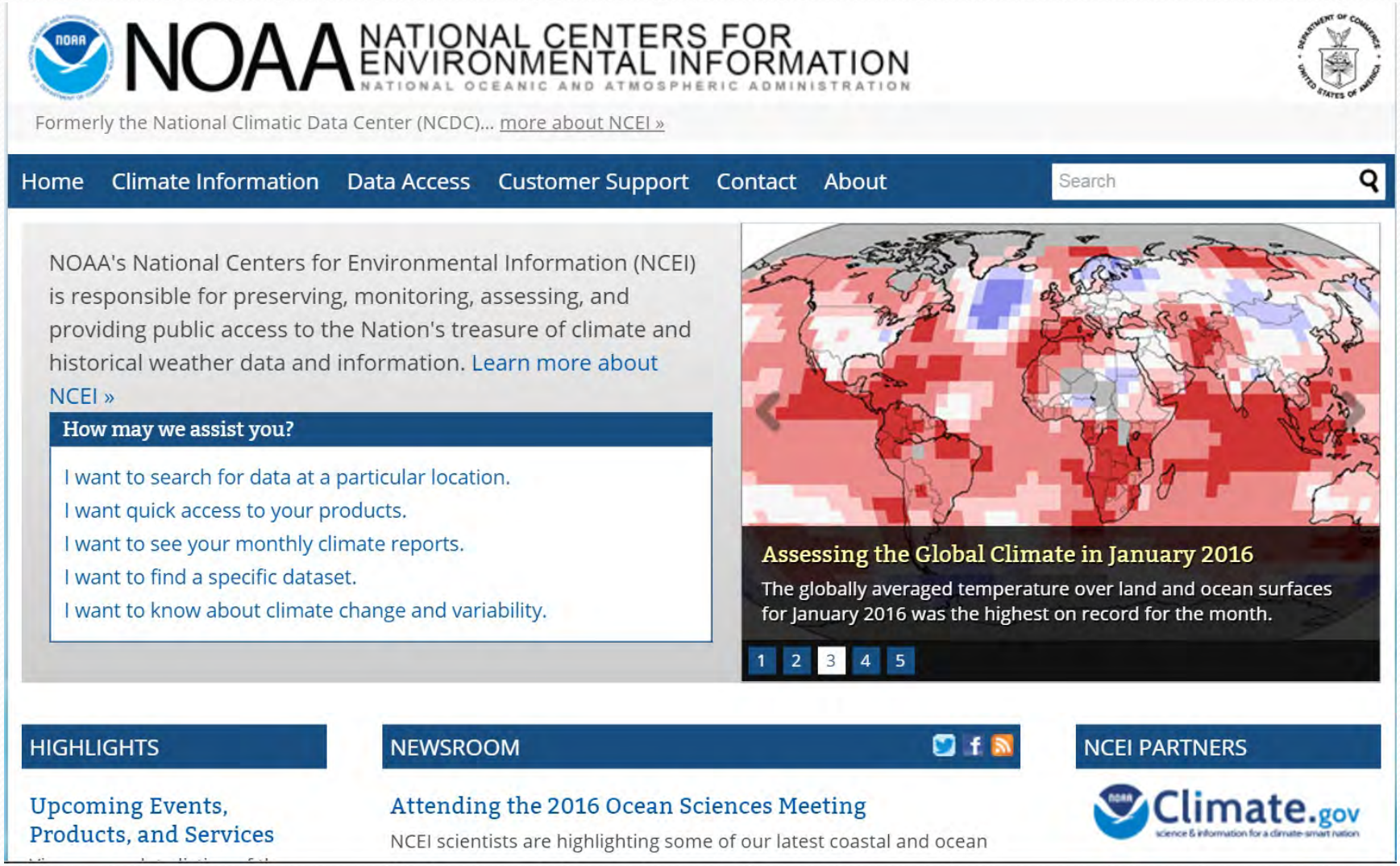
  - Ocean Heat Content - Annual

About This Snapshot:
Colors on this map show where and by how much monthly sea surface temperature differed from its 1981 to 2010 average. **read more »**

Month: Jan 2018-02-00
Year: 2013 2018
Download

54

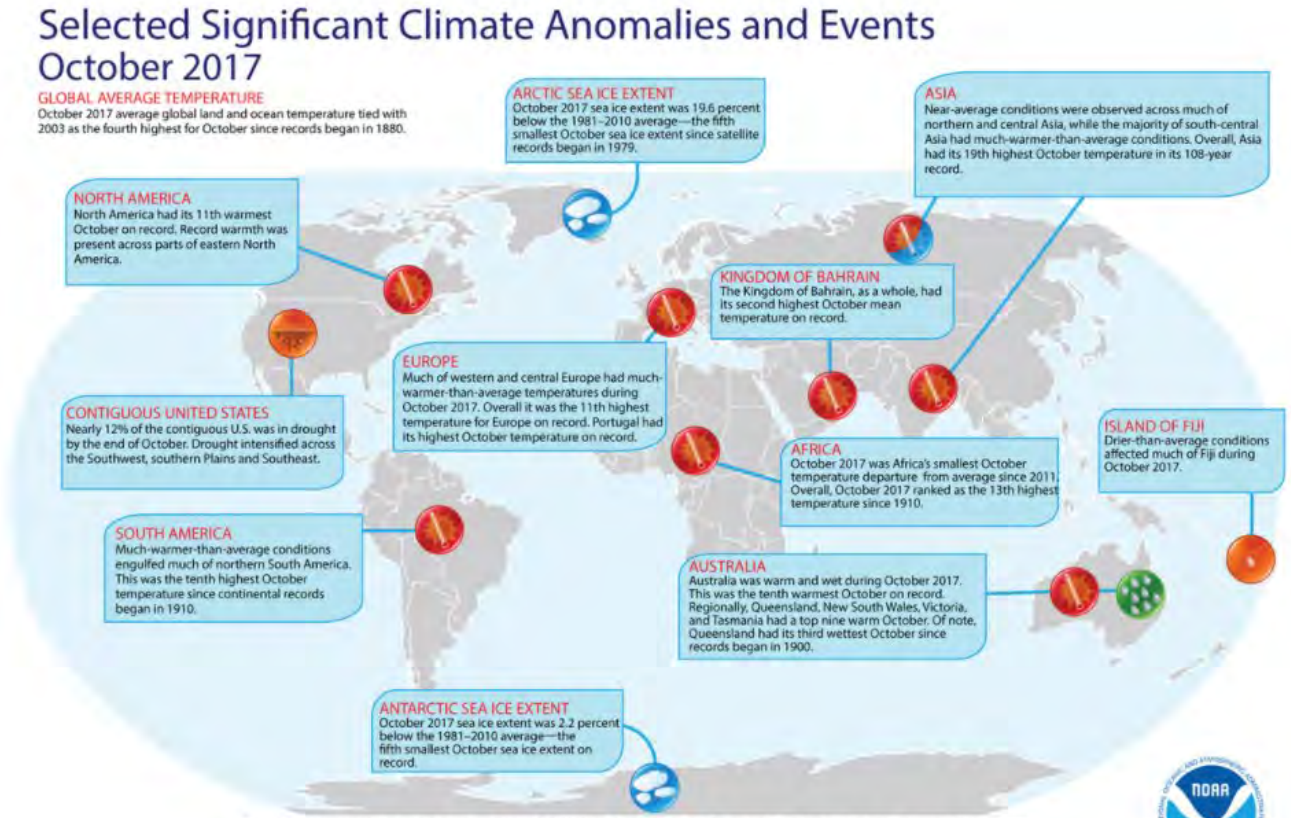
National Centers for Environmental Information



https://www.ncei.noaa.gov/

National Centers for Environmental Information

- World's largest climate data archive
- 6 million gigabytes of data



Related Links

October 2017 Global Climate Report

Climate at a Glance

Global Temperature and Precipitation

Temperature Percentiles Explained

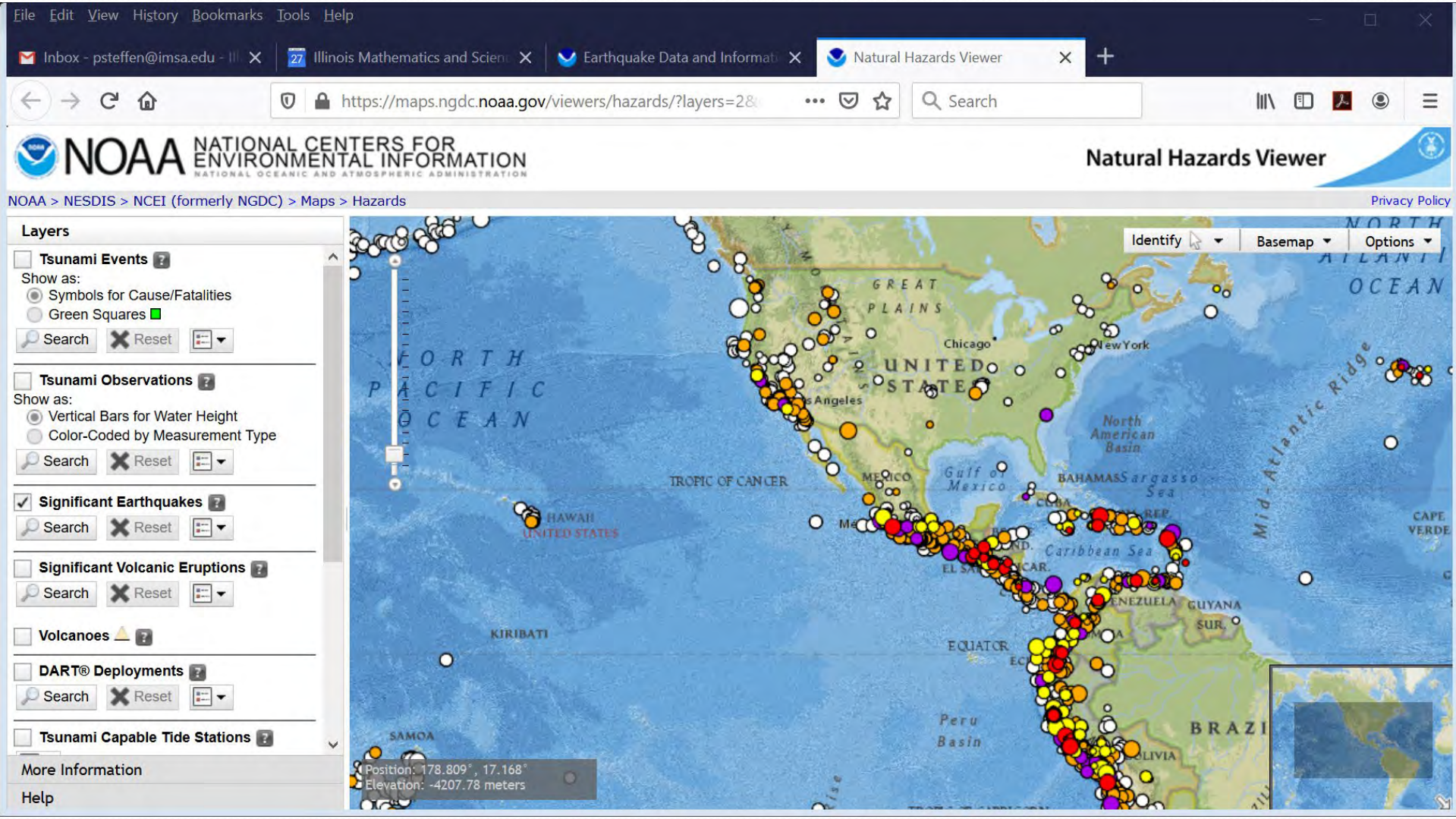
Precipitation Percentiles Explained

State of the Climate Summaries

Tags

Summary Reports Climate

Air Temperature Precipitation


File Edit View History Bookmarks Tools Help
Natural Hazards Viewer
https://maps.ngdc.noaa.gov/viewers/hazards/?layers=2&
Search
NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Natural Hazards Viewer
NOAA > NESDIS > NCEI (formerly NGDC) > Maps > Hazards
Privacy Policy
Layers
Tsunami Events
Show as:
Symbols for Cause/Fatalities
Green Squares
Search
Reset
Tsunami Observations
Show as:
Vertical Bars for Water Height
Color-Coded by Measurement Type
Search
Reset
Significant Earthquakes
Search
Reset
Significant Volcanic Eruptions
Search
Reset
Volcanoes
DART® Deployments
Search
Reset
Tsunami Capable Tide Stations
More Information
Help
Identify
Basemap
Options
GREAT PLAINS
Chicago
New York
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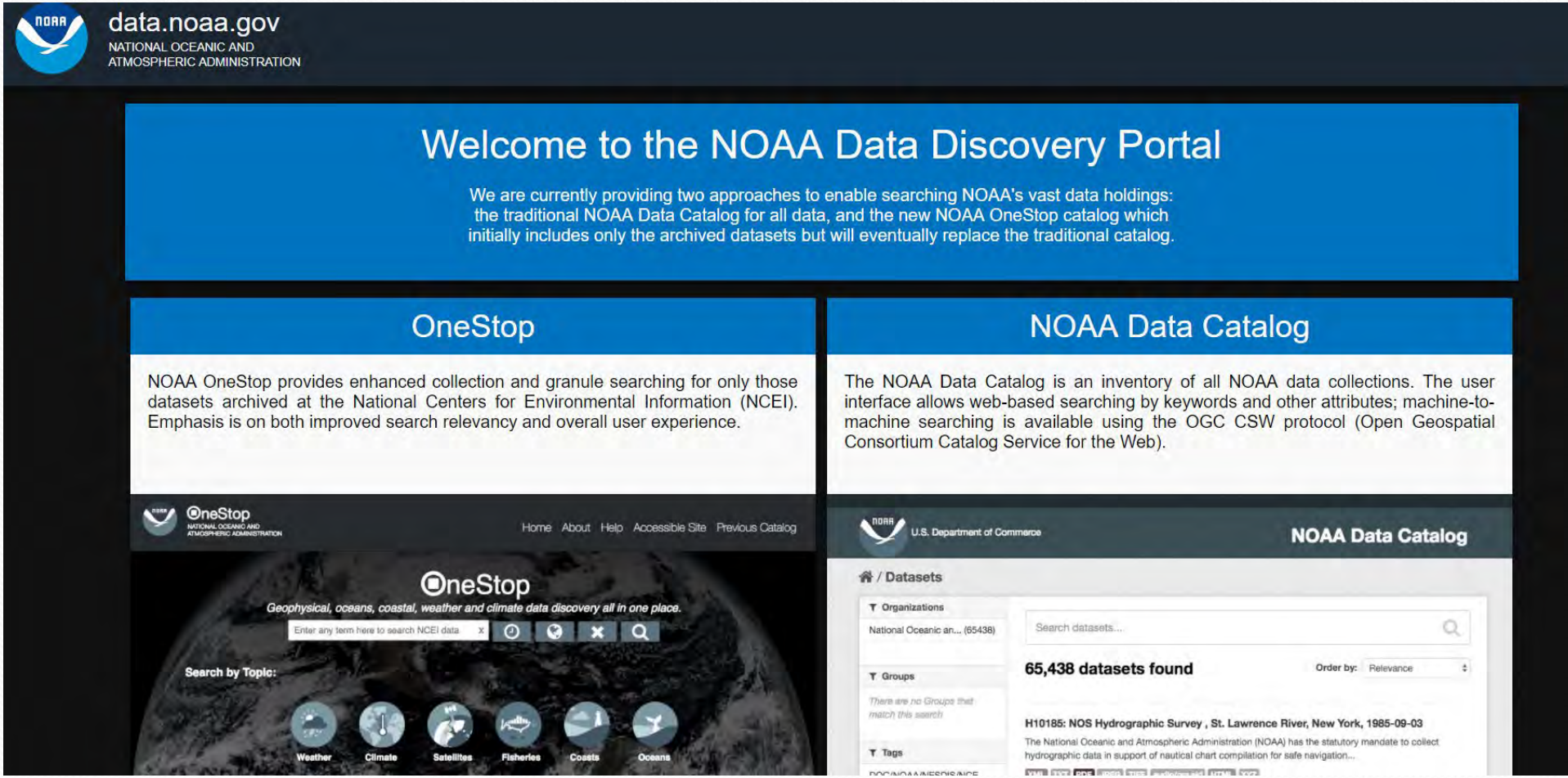
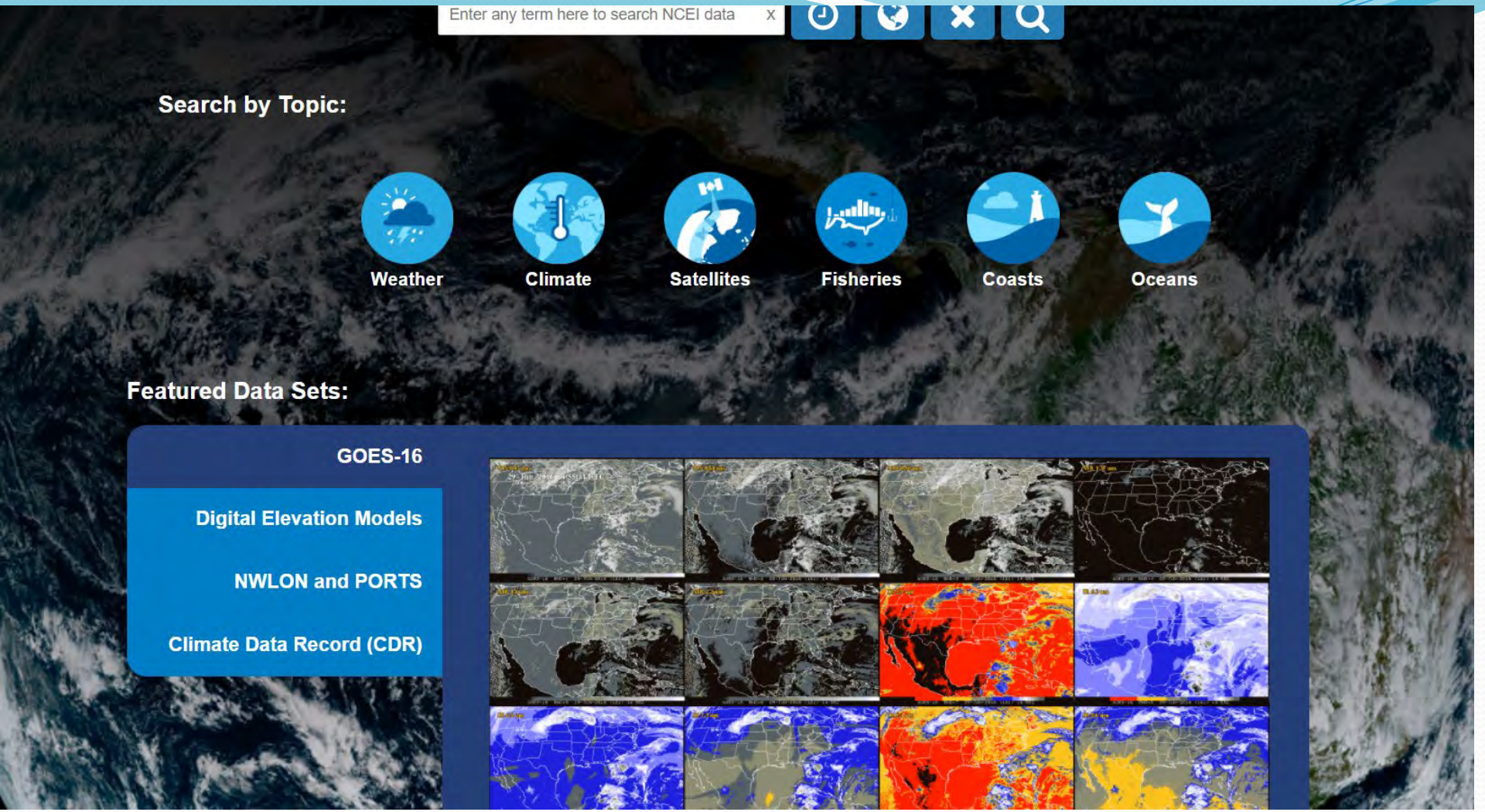
Los Angeles
NORTH PACIFIC OCEAN
North American Basin
Mid-Atlantic Ridge
TROPIC OF CANCER
MEXICO
Gulf of Mexico
BAHAMAS
Sargasso Sea
HAWAII
UNITED STATES
Caribbean Sea
VENEZUELA
GUYANA
SUR.
KIRIBATI
EQUATOR
Peru Basin
BRAZIL
SAMOA
CAPE VERDE
Position: 178.809°, 17.168°
Elevation: -4207.78 meters

https://data.noaa.gov/datasetsearch/




Enter any term here to search NCEI data
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Satellites
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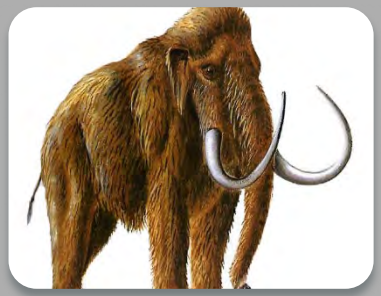
Featured Data Sets:
GOES-16
Digital Elevation Models
NWLON and PORTS
Climate Data Record (CDR)

Paleoclimate Data

http://www.ncdc.noaa.gov/paleoclimate-data

Digging Into the Past



Tracking Climate Change

A Tree Ring's Tale

Paleo climate Data

Ice Core Data

Proxy Data Sleuthing

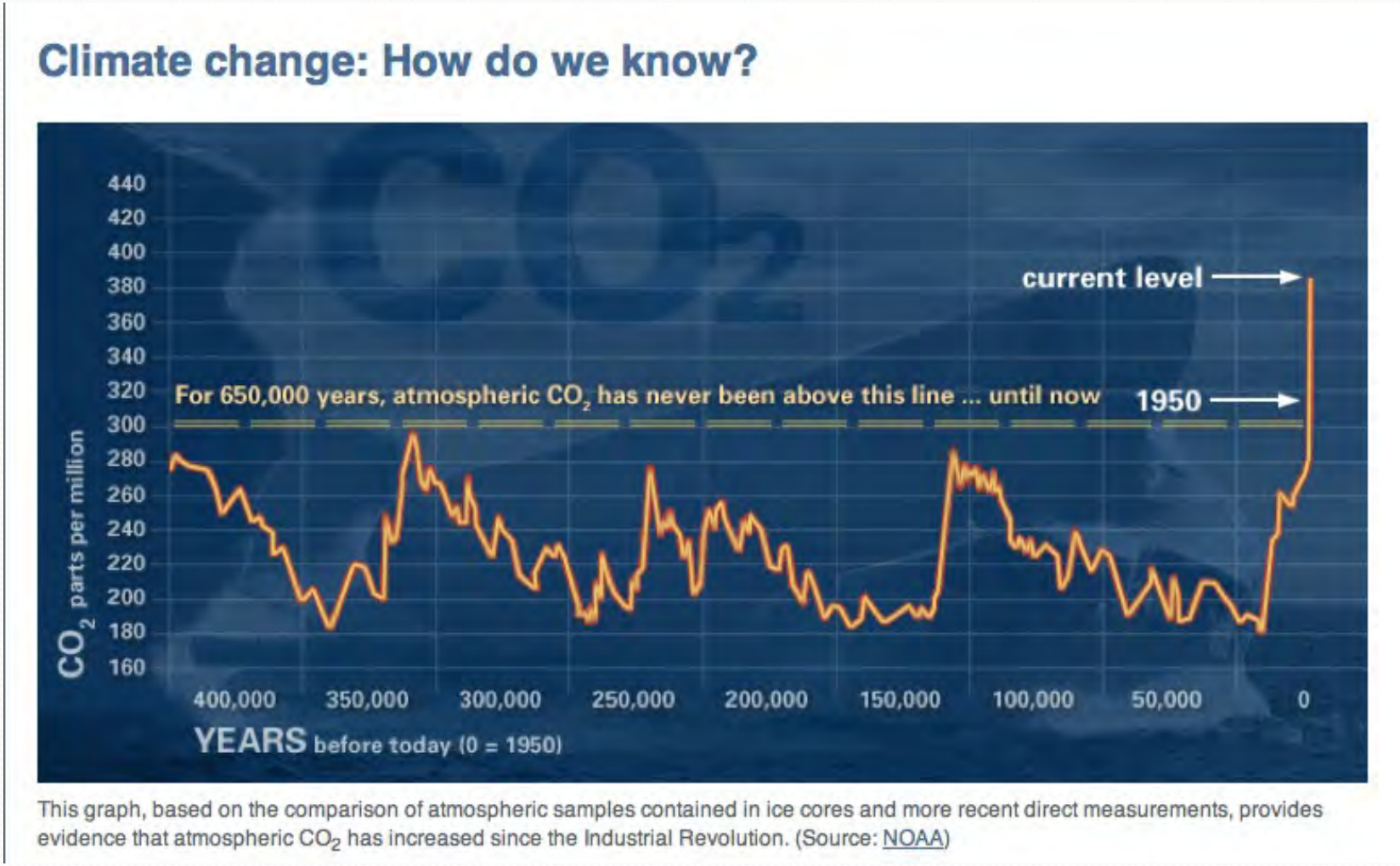
You are sitting in room with no windows for hours.

Some other people have come in an out.

How can you determine what the weather is like outside?

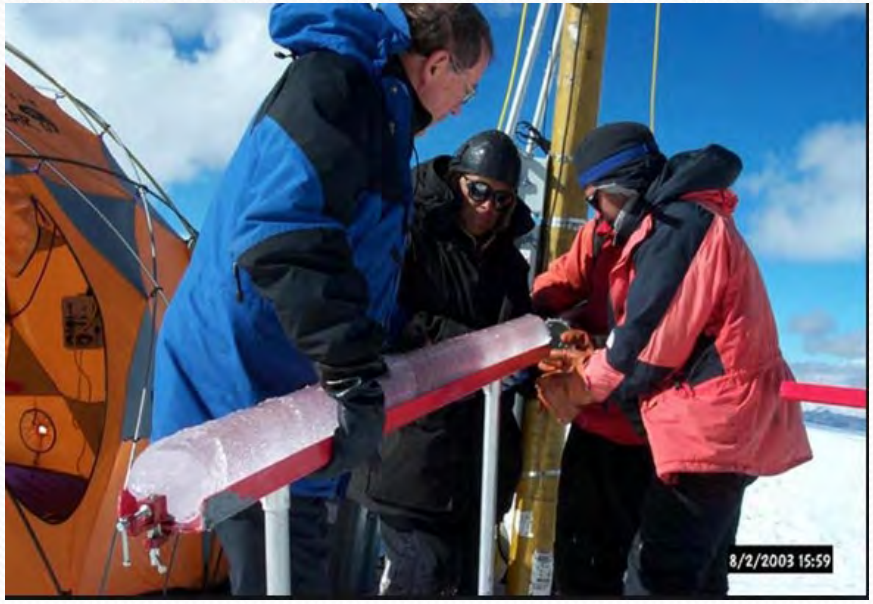
What proxy data sources could you use to deduce what it is like outside when you can’t measure it directly with instruments?

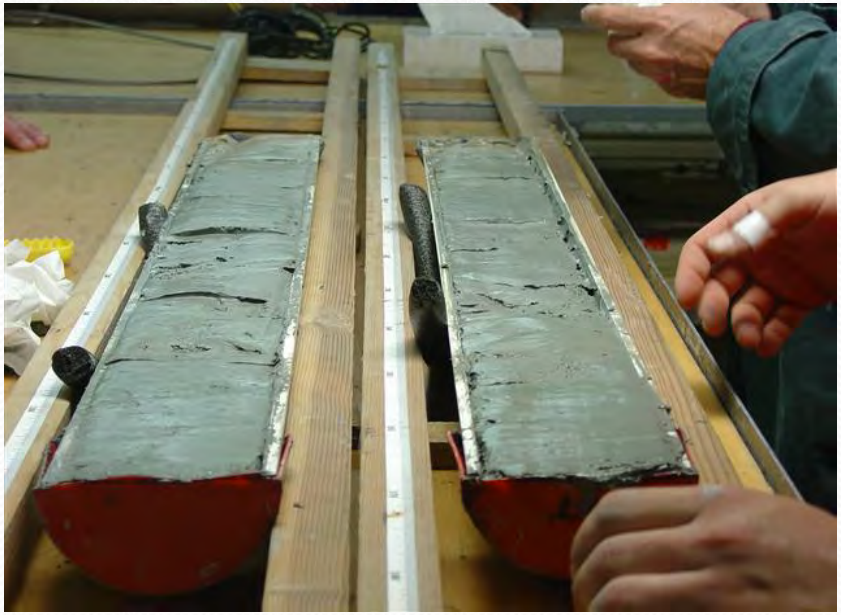
How do we know what we know about climate conditions and mechanisms of change in the past?



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Source: NOAA)

Proxy data from ice and sediment cores provides evidence of ice mass, temperature, and past atmospheric CO2 concentrations

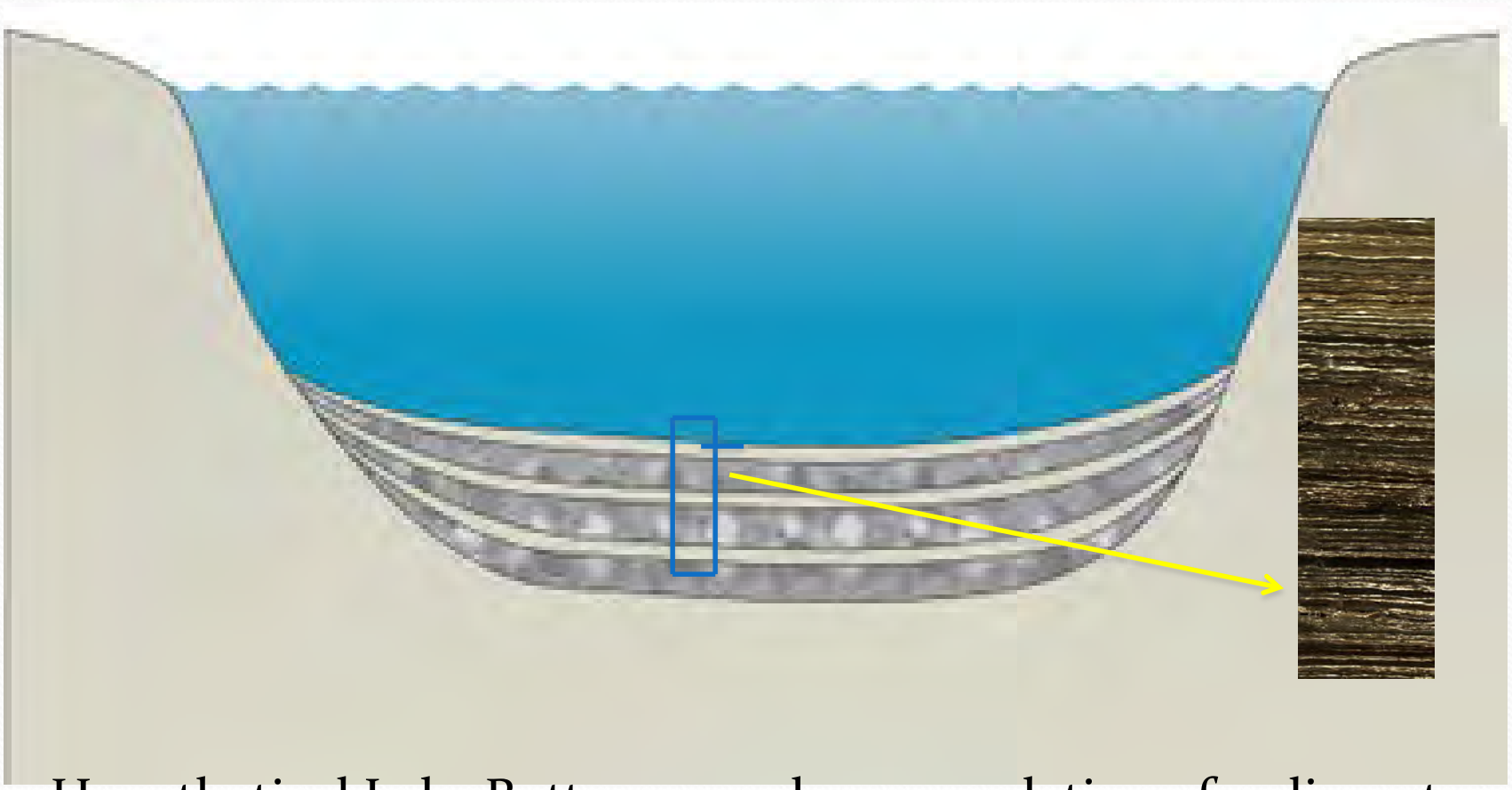




Where we find our evidence: Sediments

Story inside the Sediments

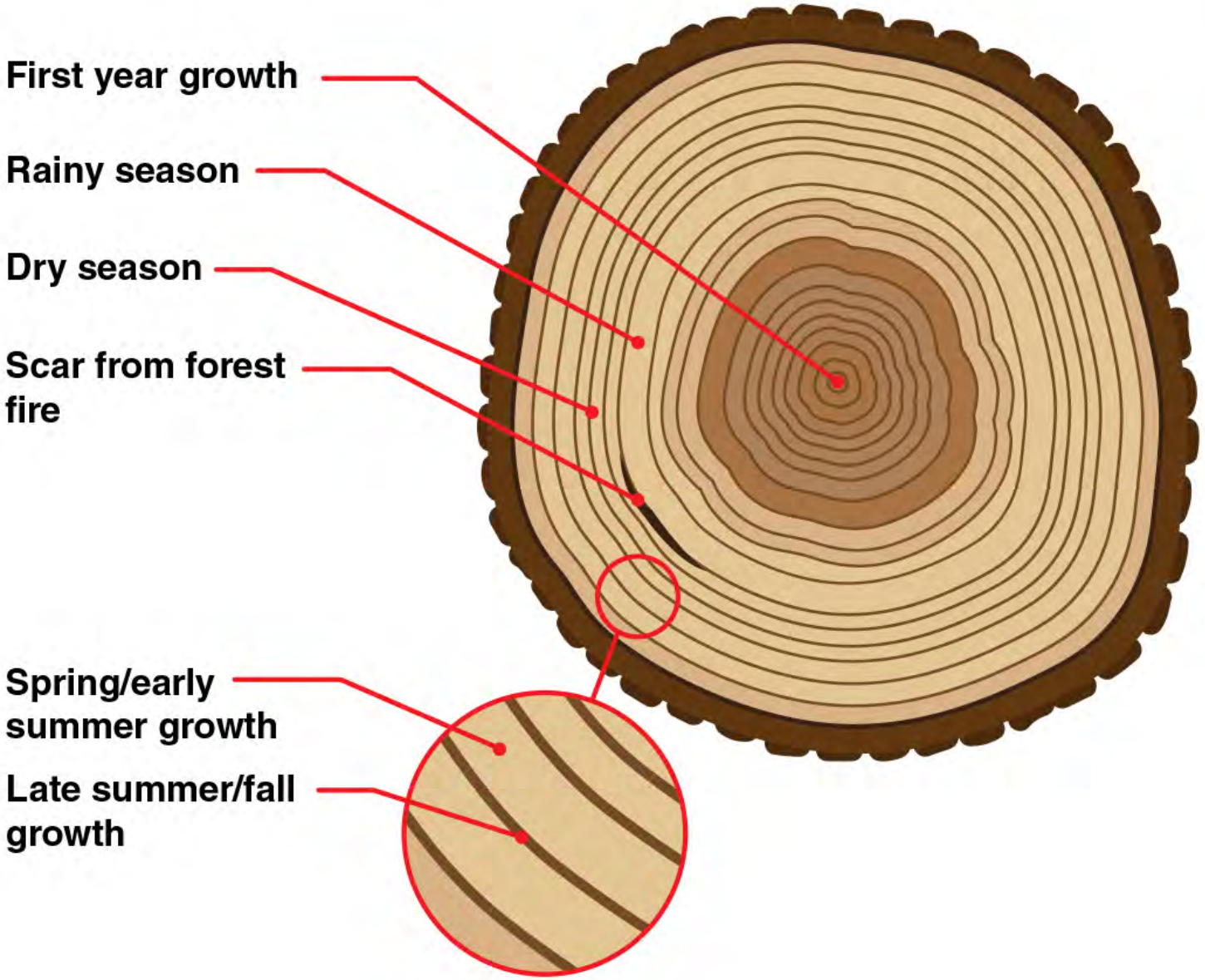
Find an archive where climate information is stored in an organized way, so that we know the sequence of events!



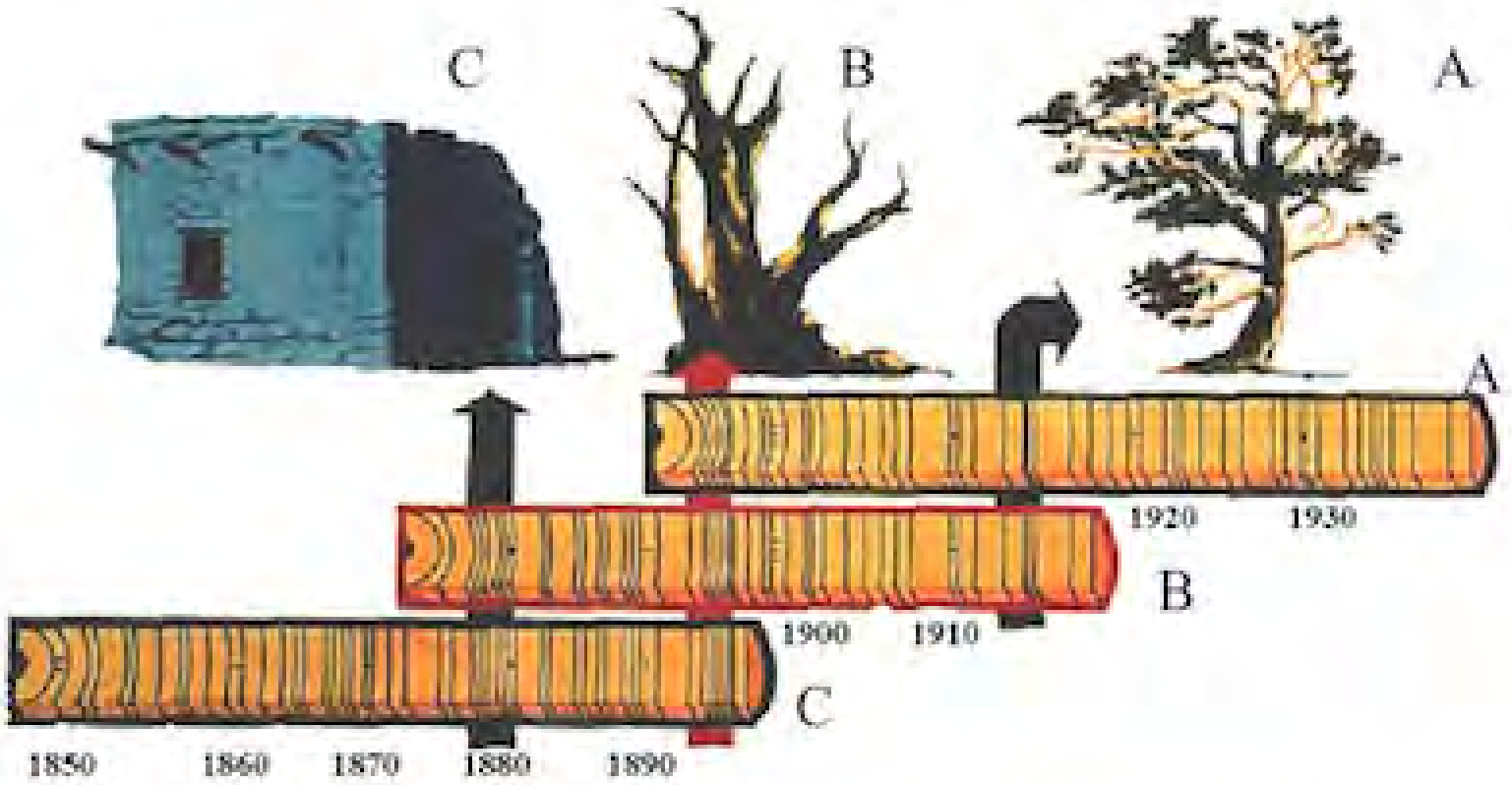
Hypothetical Lake Bottom: yearly accumulation of sediments

Summary: Proxy Data

Indirect measure of former climates or environments
Pollen, diatoms, seeds, insect remains, gases, mineral
Tree rings, ice cores, sediment, rock layers

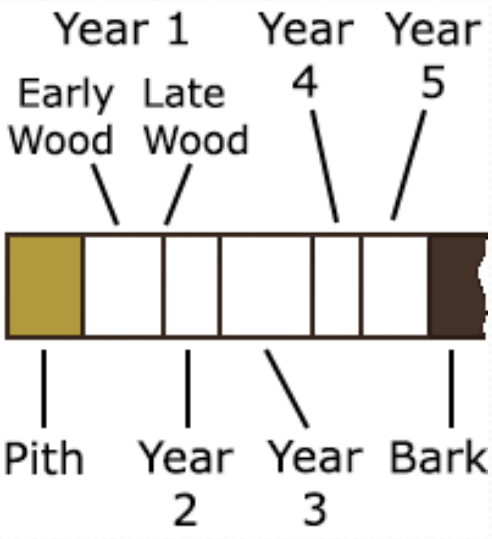

First year growth
Rainy season
Dry season
Scar from forest fire
Spring/early summer growth
Late summer/fall growth

Crossdating: The Basic Principle of Dendrochronology



<<<<<<<"Bridging" back in time<<<<<<<

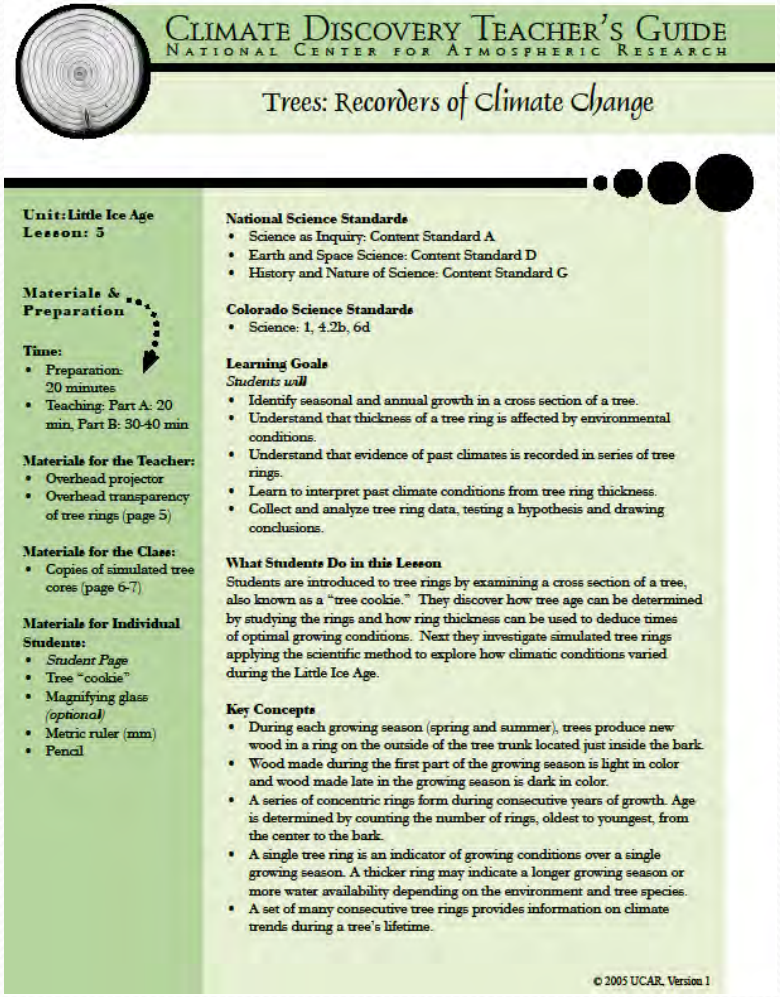
https://scied.ucar.edu/tree-ring-interactive



Core	Age of Tree	Age Growth Began
1		
2		
3		
4		

Climate Discovery Teacher's Guide

National Center for Atmospheric Research



CLIMATE DISCOVERY TEACHER'S GUIDE
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Trees: Recorders of Climate Change

Unit: Little Ice Age
Lesson: 5

Materials & Preparation

Time:
- Preparation: 20 minutes
- Teaching: Part A: 20 min, Part B: 30-40 min

Materials for the Teacher:
- Overhead projector
- Overhead transparency of tree rings (page 5)

Materials for the Class:
- Copies of simulated tree cores (page 6-7)

Materials for Individual Students:
- *Student Page*
- Tree "cookie"
- Magnifying glass *(optional)*
- Metric ruler (mm)
- Pencil

National Science Standards
- Science as Inquiry: Content Standard A
- Earth and Space Science: Content Standard D
- History and Nature of Science: Content Standard G

Colorado Science Standards
- Science: 1, 4.2b, 6d

Learning Goals
Students will
- Identify seasonal and annual growth in a cross section of a tree.
- Understand that thickness of a tree ring is affected by environmental conditions.
- Understand that evidence of past climates is recorded in series of tree rings.
- Learn to interpret past climate conditions from tree ring thickness.
- Collect and analyze tree ring data, testing a hypothesis and drawing conclusions.

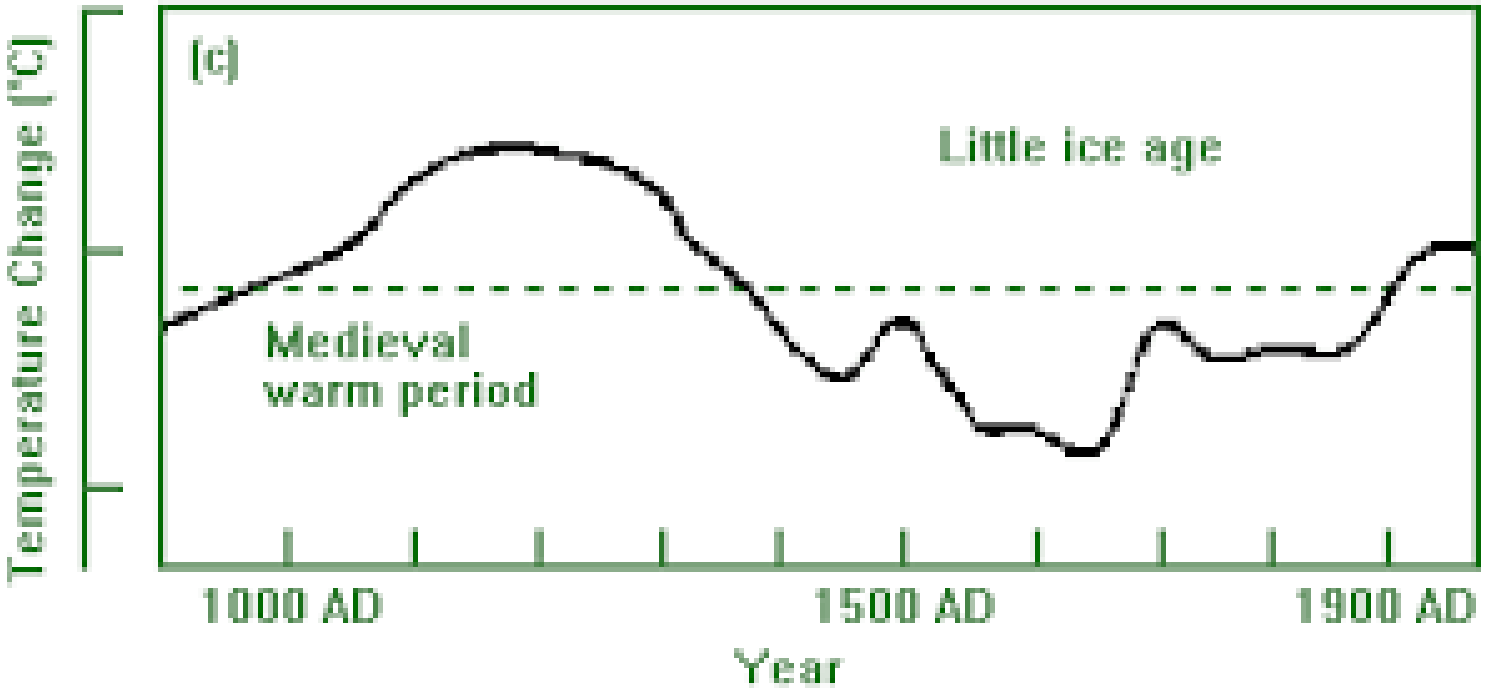
What Students Do in this Lesson
Students are introduced to tree rings by examining a cross section of a tree, also known as a "tree cookie." They discover how tree age can be determined by studying the rings and how ring thickness can be used to deduce times of optimal growing conditions. Next they investigate simulated tree rings applying the scientific method to explore how climatic conditions varied during the Little Ice Age.

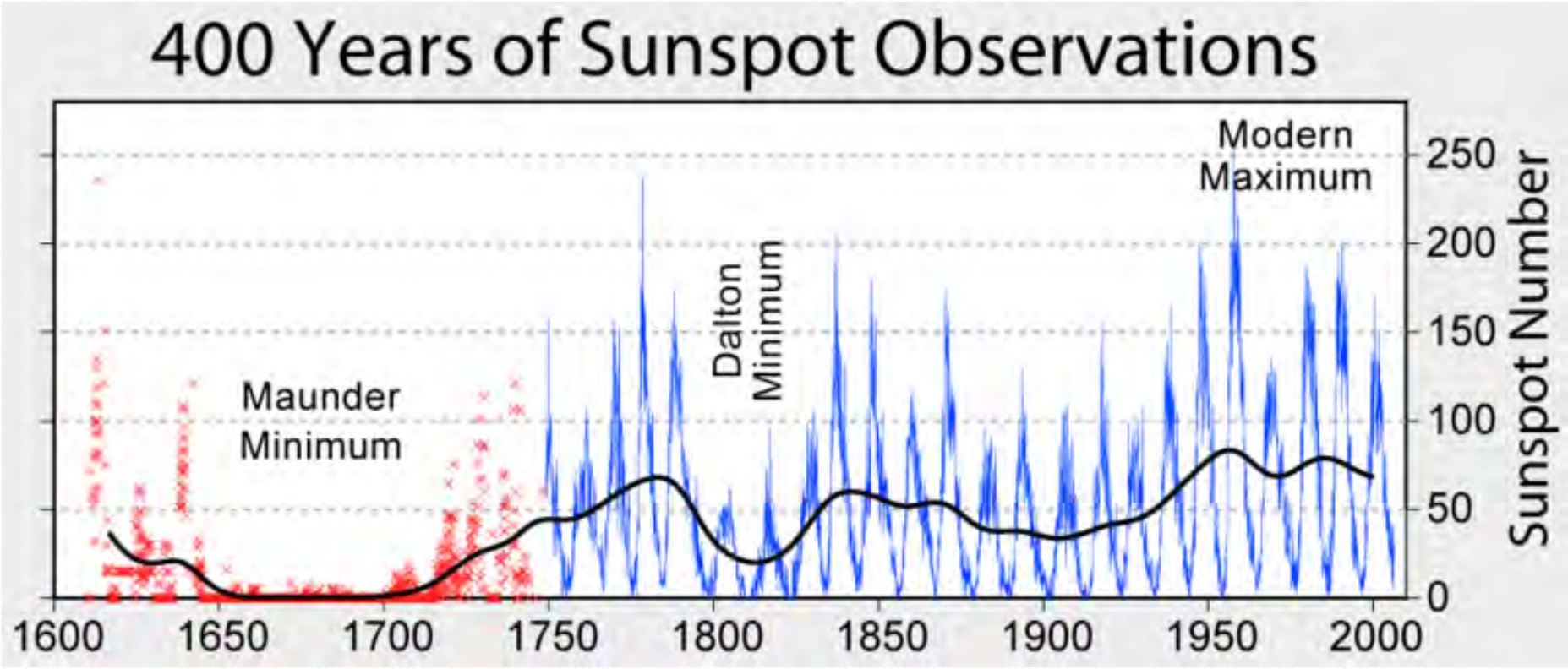
Key Concepts
- During each growing season (spring and summer), trees produce new wood in a ring on the outside of the tree trunk located just inside the bark.
- Wood made during the first part of the growing season is light in color and wood made late in the growing season is dark in color.
- A series of concentric rings form during consecutive years of growth. Age is determined by counting the number of rings, oldest to youngest, from the center to the bark.
- A single tree ring is an indicator of growing conditions over a single growing season. A thicker ring may indicate a longer growing season or more water availability depending on the environment and tree species.
- A set of many consecutive tree rings provides information on climate trends during a tree's lifetime.

Does one degree make a difference?

Let's look at the average tree ring patterns of 387 trees from northern latitudes over the past 600 years.

http://eo.ucar.edu/educators/ClimateDiscovery/LIA_lesson5_9.28.05.pdf


(c)
Little ice age
Medieval
warm period
Temperature Change (°C)
1000 AD
1500 AD
1900 AD
Year


400 Years of Sunspot Observations
Modern
Maximum
Dalton
Minimum
Maunder
Minimum
250
200
150
100
50
0
Sunspot Number
1600
1650
1700
1750
1800
1850
1900
1950
2000

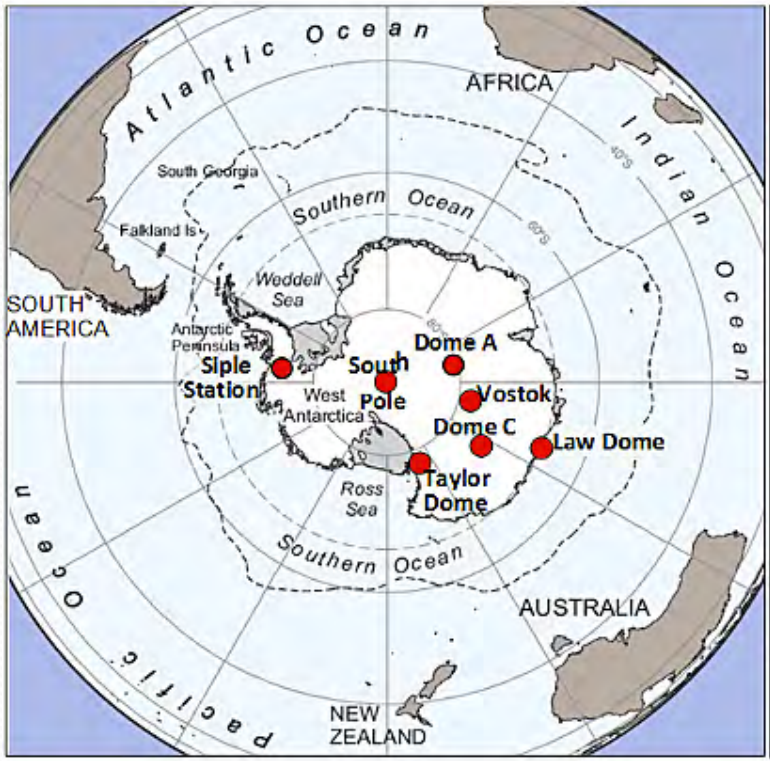
Little Ice Age

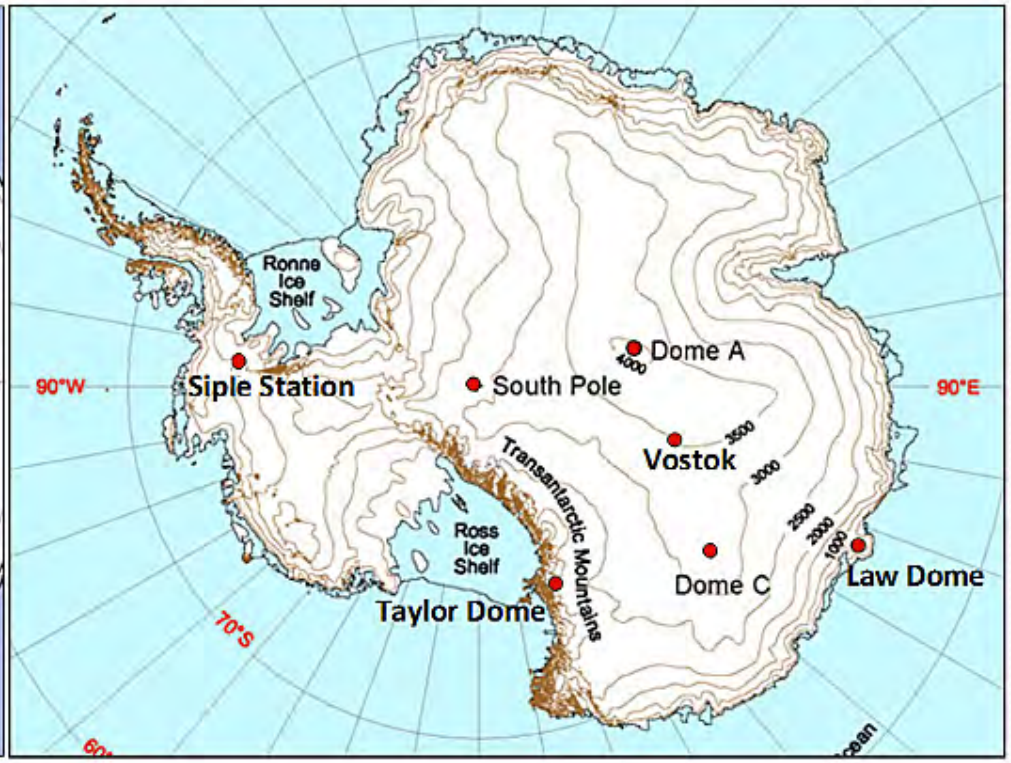
1300 to 1850
One degree colder than present
Cold winter and cool, wet summers
Widespread famine due to crop failures

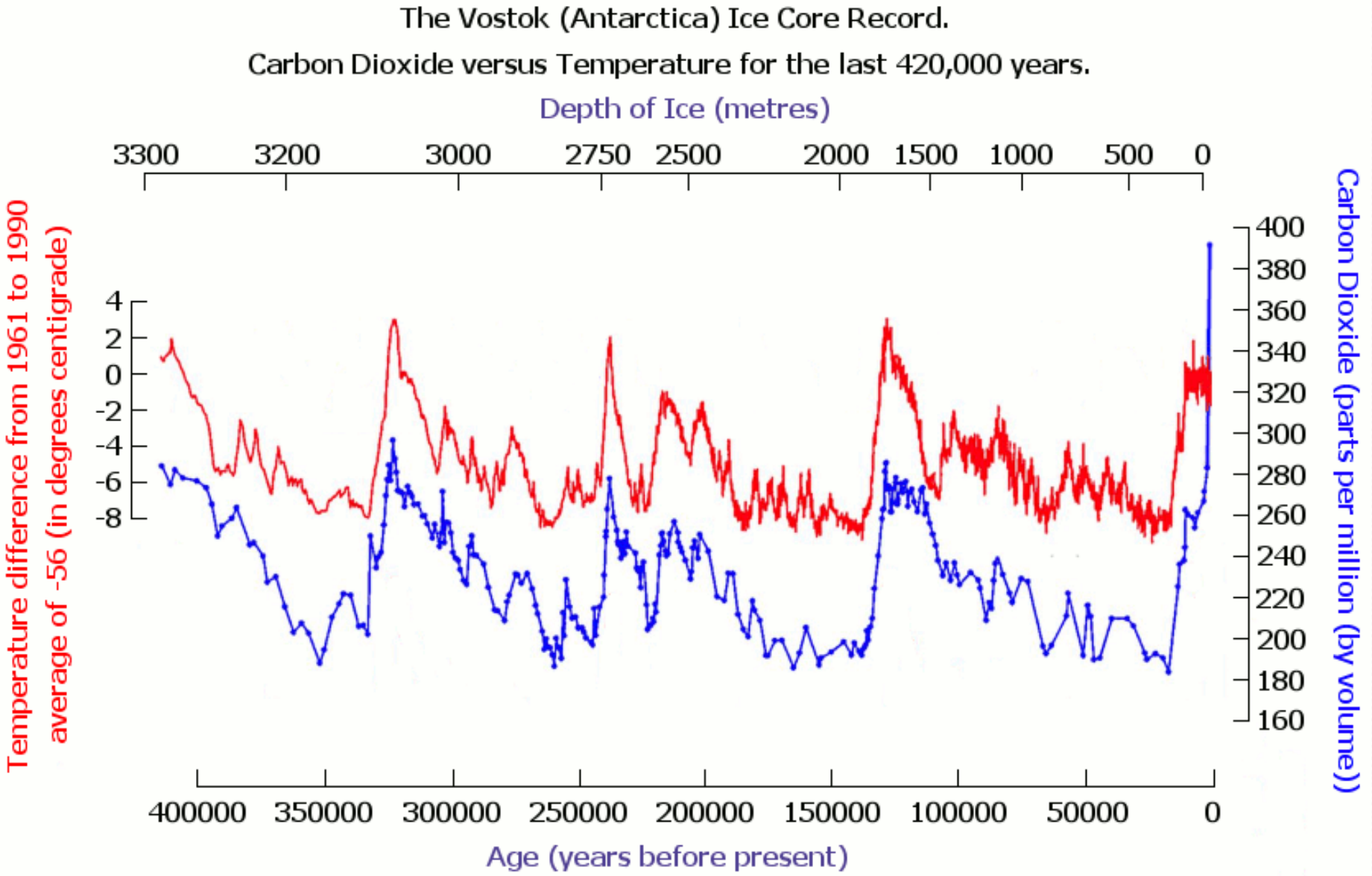
European witch trials coincided with some of the Little Ice Age's most bitter phases.
Thames River froze, Dickens wrote about the cold.
Houses and clothing were constructed for warmth.

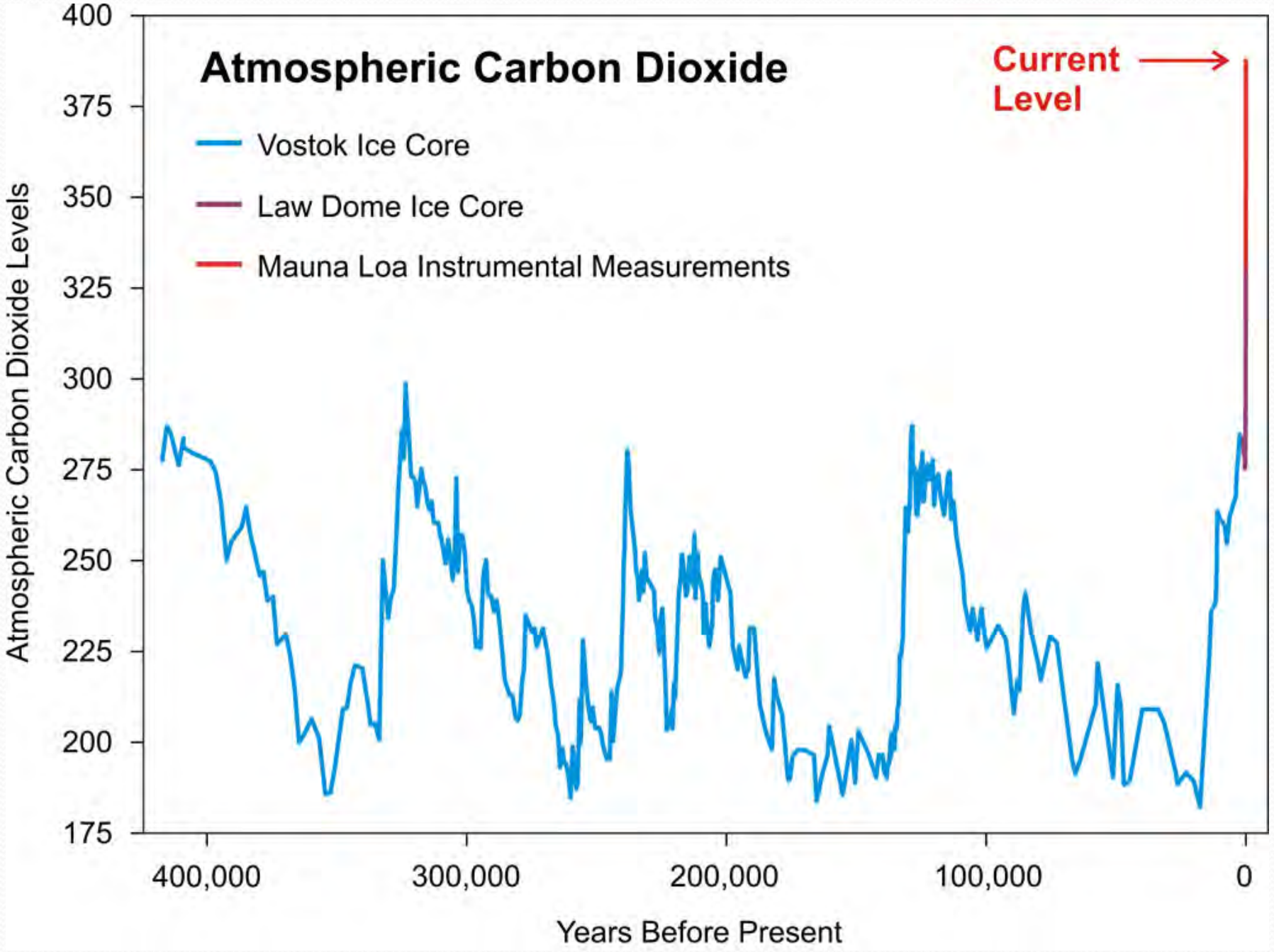
Where we find our evidence: Ice

Vostok Ice Core

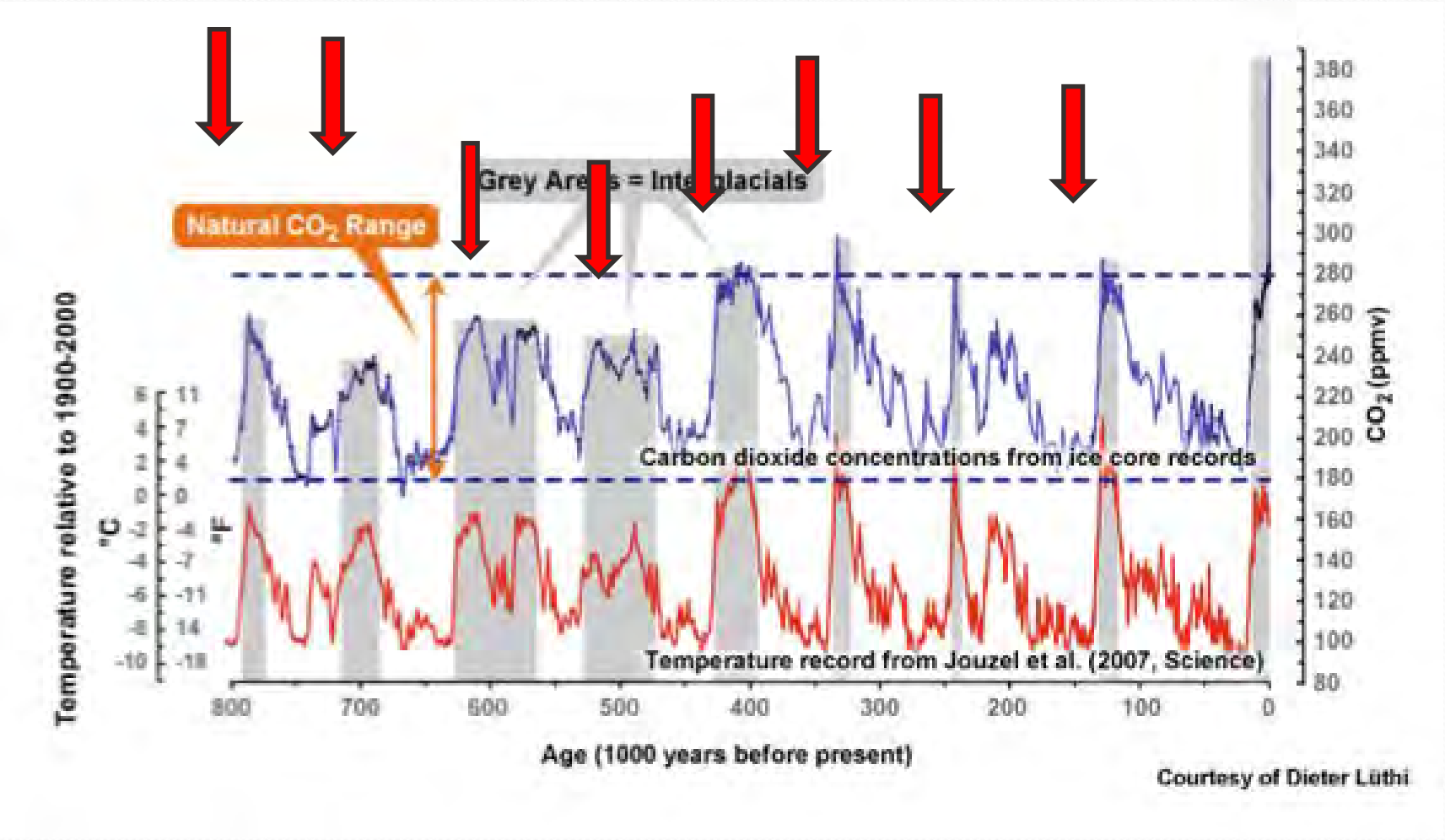





The Vostok (Antarctica) Ice Core Record.
Carbon Dioxide versus Temperature for the last 420,000 years.
Depth of Ice (metres)
3300
3200
3000
2750
2500
2000
1500
1000
500
0
Temperature difference from 1961 to 1990 average of -56 (in degrees centigrade)
4
2
0
-2
-4
-6
-8
Carbon Dioxide (parts per million (by volume))
400
380
360
340
320
300
280
260
240
220
200
180
160
400000
350000
300000
250000
200000
150000
100000
50000
0
Age (years before present)


Atmospheric Carbon Dioxide
Current Level
Vostok Ice Core
Law Dome Ice Core
Mauna Loa Instrumental Measurements
Atmospheric Carbon Dioxide Levels
400
375
350
325
300
275
250
225
200
175
400,000
300,000
200,000
100,000
0
Years Before Present

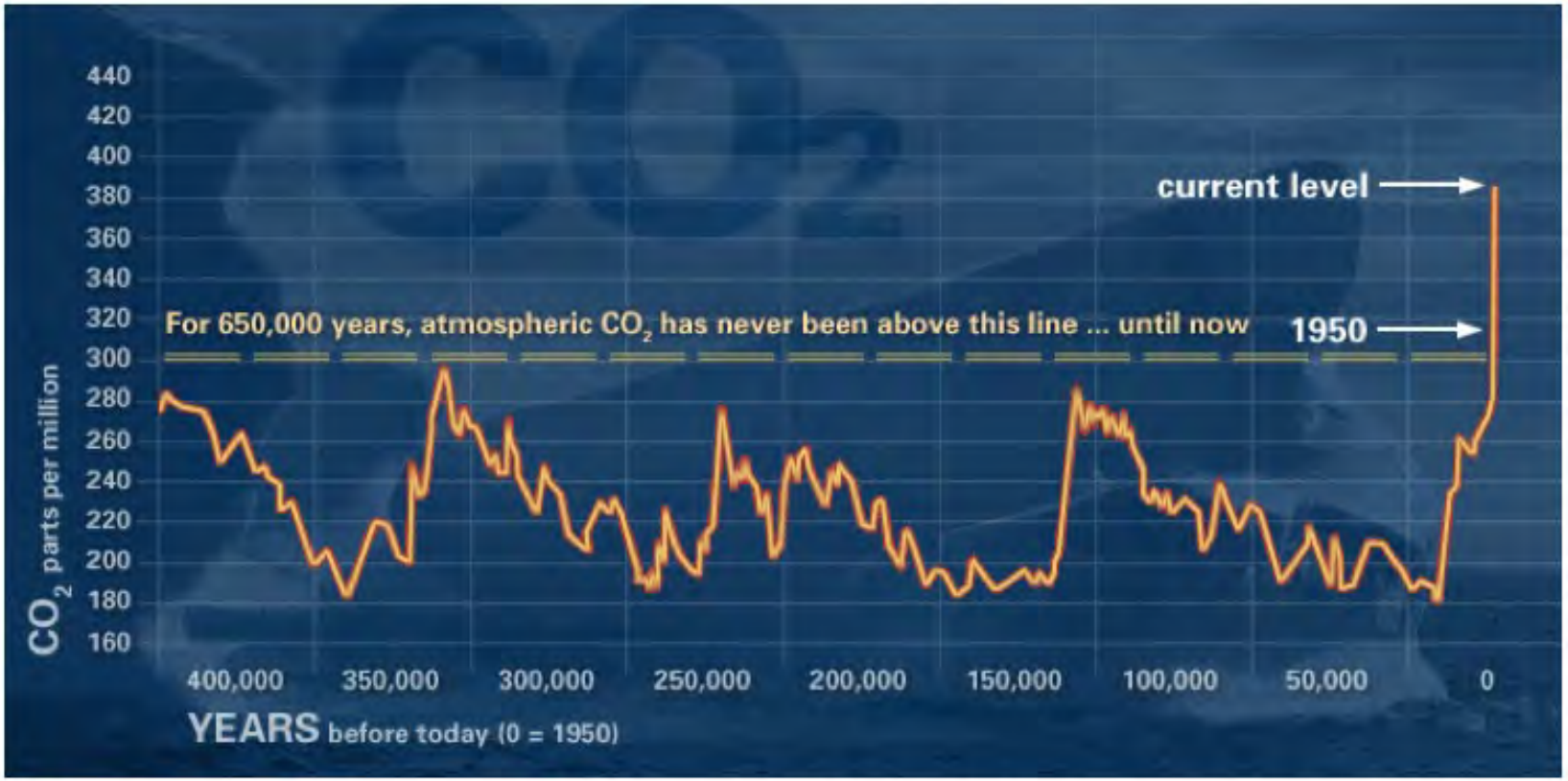
Correspondence of CO2 and Temperature on long time scales



Do you see a pattern in this data? What might cause it?
How do we know? What is the evidence?

The rate of increase of carbon dioxide is presently over 10,000 times as fast as any increase in the past.

Climate change: How do we know?



This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric CO_2 has increased since the Industrial Revolution. (Source: NOAA)


Science On a Sphere®
National Oceanic and Atmospheric Administration
NOAA
Search datasets
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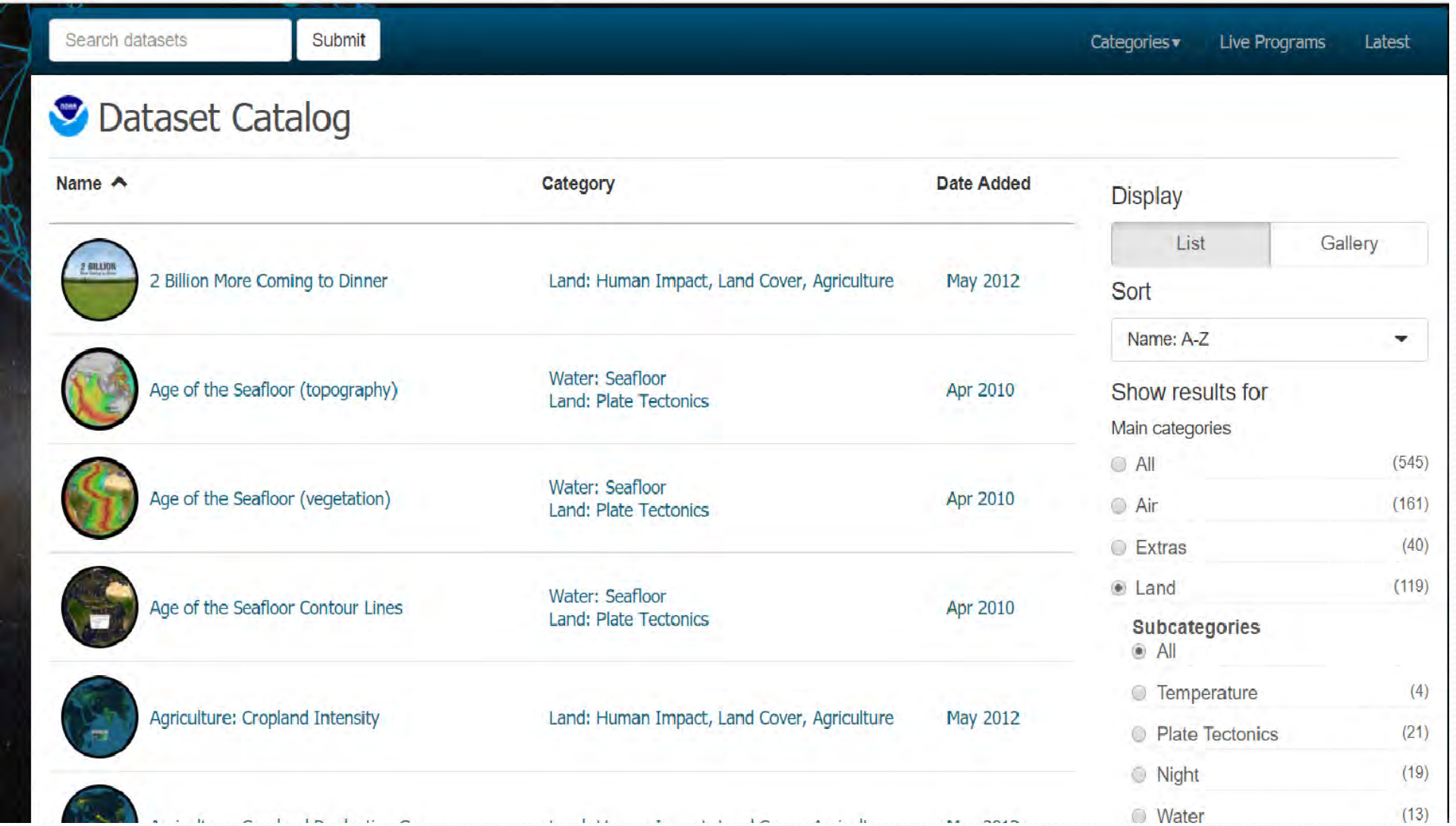
Land
ALL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Dataset Catalog
Name
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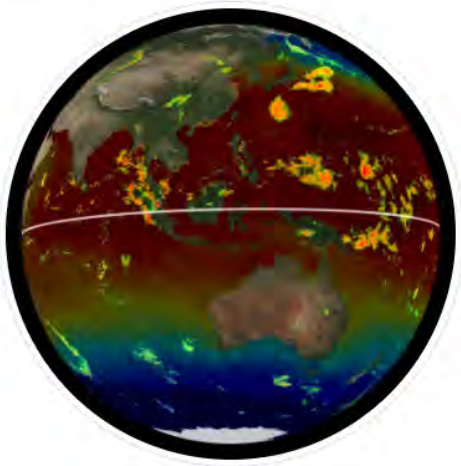
Date Added
2 Billion More Coming to Dinner
Land: Human Impact, Land Cover, Agriculture
May 2012
Age of the Seafloor (topography)
Water: Seafloor
Land: Plate Tectonics
Apr 2010
Age of the Seafloor (vegetation)
Water: Seafloor
Land: Plate Tectonics
Apr 2010
Age of the Seafloor Contour Lines
Water: Seafloor
Land: Plate Tectonics
Apr 2010
Agriculture: Cropland Intensity
Land: Human Impact, Land Cover, Agriculture
May 2012
Display
List
Gallery
Sort
Name: A-Z
Show results for
Main categories
All (545)
Air (161)
Extras (40)
Land (119)
Subcategories
All
Temperature (4)
Plate Tectonics (21)
Night (19)
Water (13)

A Global Tour of Precipitation



Description

Precipitation (falling rain and snow) is our fresh water reservoir in the sky and is essential for life. A Global Tour of Precipitation shows how rain and snowfall moves around the world from the vantage of space using measurements from the Global Precipitation Measurement Core Observatory, or GPM. This is a joint mission between NASA and the Japanese Aerospace Exploration Agency (JAXA) and offers the most detailed and worldwide view of rain and snowfall ever created.

This narrated movie will guide you through a variety of precipitation patterns and display features such as the persistent band of the heaviest rainfall around the equator and tight swirls of tropical storms in the Northern Hemisphere. At subtropical latitudes in both hemispheres there are persistent dry areas and this is where the majority of the major deserts reside. Sea surface temperatures and winds are shown to highlight the interconnectedness of the Earth system.

How to Use in Presentation

This show concludes with near-real time global precipitation data from GPM, which is provided to Science On a Sphere roughly six hours after the observation.

This video needs to be paired with the **Precipitation – Real-time** dataset, which should be played immediately after 'A Global Tour of Precipitation' video, to allow your audience to connect to current weather events that are happening.

It is encouraged to play the 'A Global Tour of Precipitation' video with z-rotation enabled to allow the audience to see the top and bottom of the sphere. The default speed of one rotation per minute is also recommended.

Length of dataset: 3:50

Notable Features

•Everywhere around the globe, rain and snowfall occur in unsteady patterns (which are hard to forecast)
•Starting at the Equator and moving toward the poles, there are alternating bands of low and high precipitation
•Swirls close to the Equator are tropical storms; at higher latitudes, lows and frontal bands are visible
Related Datasets

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Categories

Water: Freshwater
Snow and Ice: Freshwater
Air: Weather

Dataset Source

NASA Goddard Space Flight Center, NASA Jet Propulsion Laboratory, **NASA Goddard Space Flight Center / Precipitation Processing System**

Dataset Developer

NASA / Goddard Space Flight Center (GSFC)

Keywords